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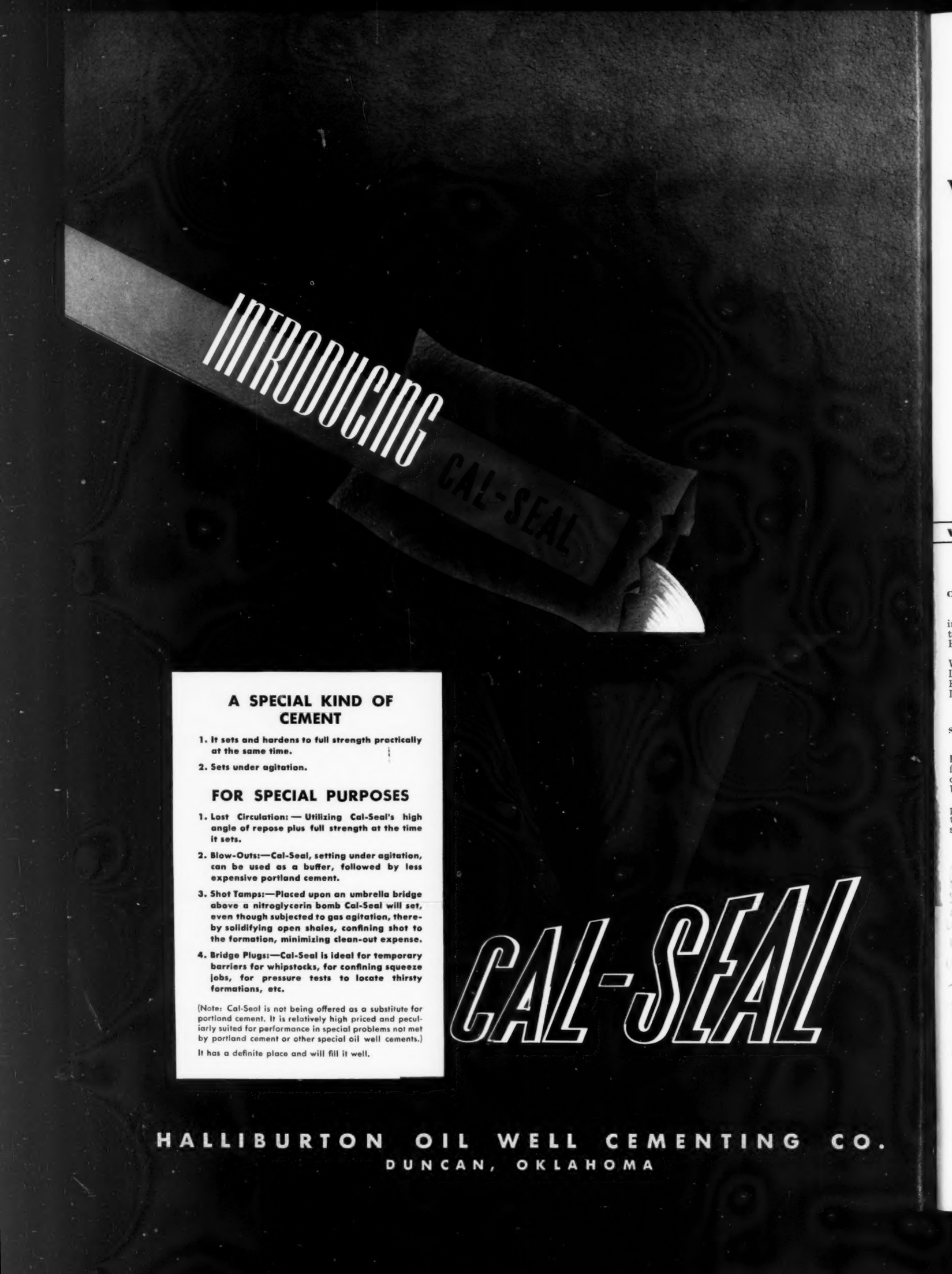
WORLD PETROLEUM

NEW YORK AND LONDON

THE OIL OUTLOOK FOR 1940



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WORLD PETROLEUM

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EDITORIAL

OIL INDUSTRY'S OUTLOOK FOR 1940

As it enters 1940 the oil industry faces some unusual conditions. War on two sides of the world has not seriously interfered with the search for petroleum or the development of its production, but it has radically changed the market mechanism in Europe and has disorganized ocean transportation. The cost of moving a barrel of crude across the Atlantic today has become more than the oil itself was worth a few years ago.

In the United States domestic consumption of motor fuel established a new high in 1939, exceeding 550,000,000 barrels, a gain of nearly five percent over 1938. Sales of gas oil and fuel oil likewise increased, being 12 percent above 1938 and slightly higher than in 1937 which previously held the top record. In spite of the active demand for their principal products the earnings of most of the larger companies for the past twelve months apparently will be lower than in 1938 which in turn were below those for 1937. The explanation of this condition is to be found in the fact that average prices were lower in 1939 than in either of the two preceding years. Failure of the industry to obtain a reasonable return from the sale of its products still constitutes a major problem.

Crude oil production in the world at large averaged 5,690,000 barrels daily during 1939 of which a little over 3,450,000 barrels or approximately 60 percent represented production in the United States. The latter production threatened to get out of bounds when it rose to above 3,900,000 barrels daily at the beginning of August. This trend was corrected by the shutdown of wells in six states during the latter part of that month and the year ended with crude stocks below 240,000,000 barrels or less than at any corresponding period during the past decade.

A less satisfactory picture is presented by motor fuel stocks which at 80,000,000 barrels are 10 percent higher than a year ago and are expected to attain the unprecedented figure of 95,000,000 barrels or more by March next if output continues at the present rate. As this quantity will tax available storage facilities the practically certain result will be distress offerings which may weaken gasoline prices at the very beginning of the season of growing consumption.

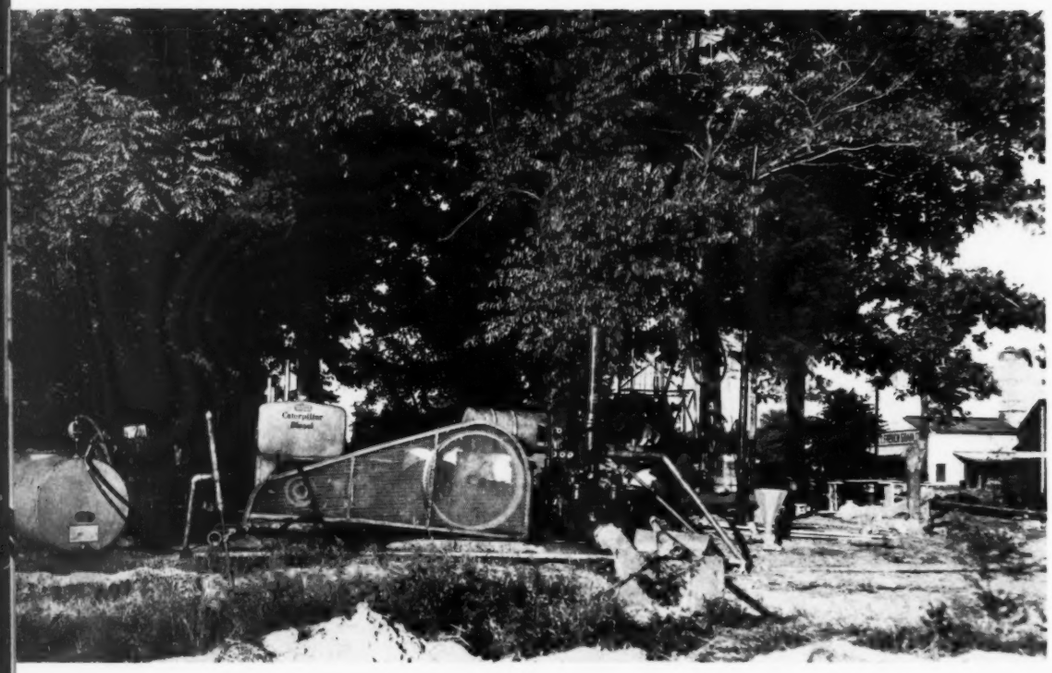
For the coming year most statisticians predict for the United States a further gain in the consumption of motor fuel, basing their estimates on the increased registration of motor vehicles and the larger production schedules planned by automobile manufacturers. Should an expansion in industrial operations take place as confidently anticipated by many observers it would lead to the increased use of fuel oil and lubricants and possibly also of kerosene and asphalt, the two latter being determined primarily by agricultural activity and road building. The prospect of such increase in demand gives added importance to the desirability of establishing a sound price structure.

Contrary to general expectation war in Europe has not enlarged the export demand for American oil products except in two or three special lines. Actually exports declined immediately following the outbreak of hostilities. Several factors have contributed to this result. One of the most important has been the disorganization of Atlantic shipping, the withdrawal of United States vessels from North European waters and the advance of 200 percent in tanker rates. Except for the swift incursion of German troops into Poland the war has not been one of action so far as land forces are concerned. Even in the air no large scale operations have taken place. As a consequence of the general restrictions placed on the private and commercial use of motor vehicles both by belligerents and neutrals consumption of motor fuel in most European countries has been less since September 1 than under normal conditions. Trans-Atlantic shipments to Germany which ordinarily are of substantial volume were shut off with the declaration of war while the assumption that supplies moving from the Near and Far East to Britain and France might be interrupted has not been realized. While it is possible that military operations will assume a more dynamic character with the coming of spring and so lead to increased purchases from North and South America well informed observers do not count on any considerable expansion of export trade during 1940.

In the matter of oil industry machinery, however, both in drilling and refinery equipment, a continued expansion in export demand is practically assured. Companies engaged in exploration and development in South America, the Near East and the Far East, and even in Europe itself, instead of suspending their operations because of existing conditions are rather intensifying their activities on the sound assumption that whatever may be the course of events during the war they will face a greatly increased demand for all petroleum products at its conclusion. In view of the preoccupation of both Germany and the United Kingdom with more urgent affairs most of the needed equipment must be supplied from the United States and many manufacturers are now working on extensive orders for delivery during the coming months.

On the political front the oil industry of the United States faces a renewed effort to extend the authority of the national government over its operations within state boundaries. At its annual convention at Chicago in November the industry went on record as opposed to the proposed legislation and state authorities are equally outspoken against it. Outside a narrow circle of federal officials there seems to be no demand for federal intervention and the belief is general that if Congress enacts an oil measure at the session now beginning it will differ materially from the bill placed before it at the behest of the administration.

←Photo by Robert Yarnall Richie



Despite temporary unsettlement caused by unrestricted production in Illinois and elsewhere, Col. Thompson advocates state control.

All Industry Should Resist Federal Encroachment on State Powers

By Col. Ernest O. Thompson
Chairman Interstate Oil Compact,
Member of Railroad Commission of Texas.

THE oil industry is going into the new year 1940 with the best prospects it has had in many years.

Stocks of crude above ground have been reduced from a high of 450,000,000 bbl. to a low of around 250,000,000 bbl. This in my opinion is as low as economic operation will allow. It might be possible to have uninterrupted operation of refineries with slightly lower stocks of crude if the stocks of crude and the stocks of gasoline were properly distributed. But this could never come about except under an undesirable, and to us in America, an intolerable totalitarian Fascist or Nazi government.

It is desirable and necessary in a democratic government and a profit motivating industry that we do not have this kind of perfection.

The constant competition between crudes and between fields and areas, and the competition between states and even between countries, is good for everyone concerned.

It must always be kept in mind that every division of the oil industry from the land owner, the producer, the royalty owner, the refiner, the transporter to the marketer are all in business to serve the consumer.

There are more consumers than there are producers, royalty owners, pipe liners, refiners and marketers.

The consumer is entitled to have his motor fuel produced, refined and marketed by the most advanced and most efficient known methods.

Old, inefficient, wasteful methods cannot longer prevail.

The consumer, acting through his state government's police power, will stop waste in production of oil and gas.

The profit motive in a free competitive field will compel the adoption of the most efficient methods and practices in the refining, transporting and marketing branches of the industry.

This is all the control that is needed in the oil industry.

Any further control by government is unnecessary and undesirable.

Any further control by government would be a change in our form of democratic government.

It is more important that we preserve our American form of government, with its division between state and federal authority, each sovereign in its separate sphere of action, than it is to achieve somebody's idea of engineering or scientific perfection.

As between the two it is far better to tolerate a little waste in oil production than to give up the freedom of our sovereign states to control their production within their own borders.

The waste can be finally prevented, but once our state sovereignty is surrendered even one iota we have forever lost the most precious thing on earth to the proud citizens of our sovereign states.

There is something in this world far more desirable than cold efficiency. It is freedom.

We were thousands of years evolving this form of freedom under democratic government.

The action of tyrants and dictators brought about the creation of the American government.

It was carefully and thoughtfully planned and designed to keep the power of the government close at home. It has succeeded better than any form of government on earth.

Let us not place in jeopardy our proven form of government or change it just because somebody is not producing oil or gas as efficiently as some theorist would desire or compel if he had the power.

I do not admit that the federal government could do any better job of preventing waste in oil and gas production than the states are doing.

The states are fast learning how to prevent physical waste. Those states who do not now have waste prevention laws will soon have them. Informed public opinion within the states will compel it. That is a task of education within the states. Abuse will not do the job.

The whole science of producing oil so as to prevent avoidable waste is new.

We should not get all in a dither over such a newly discovered and highly controversial science or technique.

If the federal government thinks it needs some oil for naval or army reserves then let the government buy outright some complete oilfield of ample reserves of proven production and shut that field in completely and hold it against the need.

The natural reservoir in the earth is the best and safest storage tank. No one could touch it or waste it through the ages.

The government buys gold and buries it in Kentucky for a reserve.

Why not buy an oil field and keep the oil in the ground for a defense reserve?

That is exactly what the government did at Amarillo, Texas, in the helium gas producing field. The government thought it needed a helium reserve, so the Congress made an appropriation and the government bought outright 50,000 acres of helium gas producing land and is now holding it against the need.

Oil is not the only industry concerned in this move for nationalization. It is just the medium through which an extension of federal control and federal domination and federal dictation is sought to be extended.

This attempt to control oil production is just another raid upon the powers of the sovereign states.

If oil is taken over by the Washington bureaucrats, would be in line thereafter for Federal control.

The issue is up to all industries to help check this constant centralization of all power in Washington.

Record Oil Consumption in 1939 Brings Reduced Profits, Record Taxes to U. S. Producers

By Axtell J. Byles

President, American Petroleum Institute

NEARLY every manufacturing and consumption record of the petroleum industry was broken in 1939, but early estimates indicate that the industry's net earnings will be below even the reduced profits of 1938. Consumer prices generally slipped to near-record lows.

Several new catalytic, chemical, and thermal refining processes, further assuring more-than-adequate supplies of super aviation fuel and also advancing the development of a host of synthetic basic industrial chemicals, were announced in 1939. These are only a few among many technological advances made in all branches of the industry during the year.

Discovery of oil in commercial quantities in Mississippi and Nebraska in the last quarter brings to 23 the number of oil-producing states in the United States, and, with the new fields and new producing strata opened up in other states during the year, adds substantial quantities of crude oil to the nation's proved reserves. These developments re-emphasize that American consumers need fear no exhaustion of petroleum.

Incidence of European war had little effect on the industry. Exports of motor fuel, for example, declined in October, the month of latest available statistics. Industry economists made no prediction for 1940, but point to the unusual nature of the war, the loss of the Central European countries as customers, the substantial Asian and South American sources of supply now open to England and France, and to the rationing of petroleum products throughout Europe, as evidence that the war may continue to have little effect on the petroleum trade of the United States in 1940.

Late in September the Temporary National Economic Committee began a four-week investigation of the industry. Testimony presented convincing evidence that the industry is typical of the best in the American system of free enterprise, and is thoroughly capable of solving its own problems. Another Congressional group, the Cole Committee, has been conducting hearings on the Cole bill, designed to effect federal control of oil

Crude Oil Prices
(Per bbl. of 36 deg. A. P. I. gravity Oklahoma-Kansas oil)

Year	High	Low
1933	$1.00	$ .25
1934	1.00	1.00
1935	1.00	1.00
1936	1.10	1.00
1937	1.22	1.10
1938	1.22	1.02
1939*	1.02	1.02

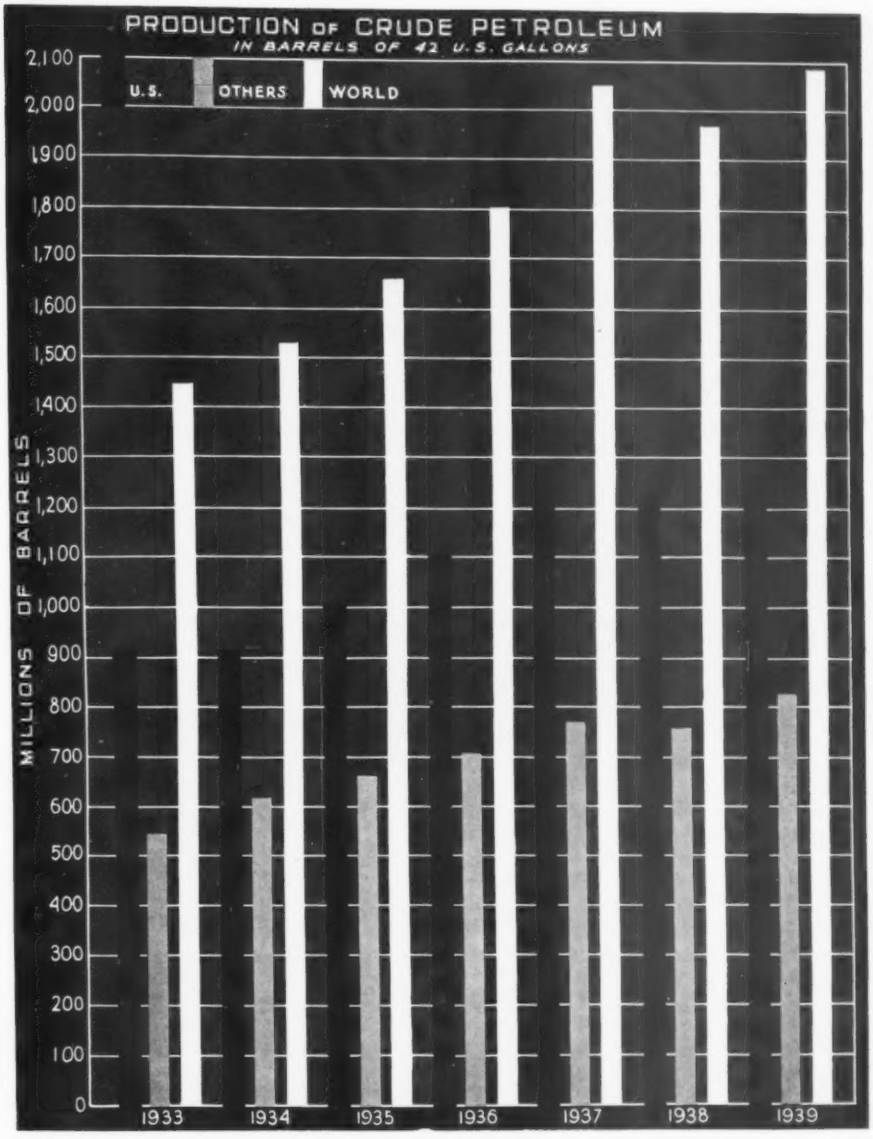
*Up to December 15, 1939.

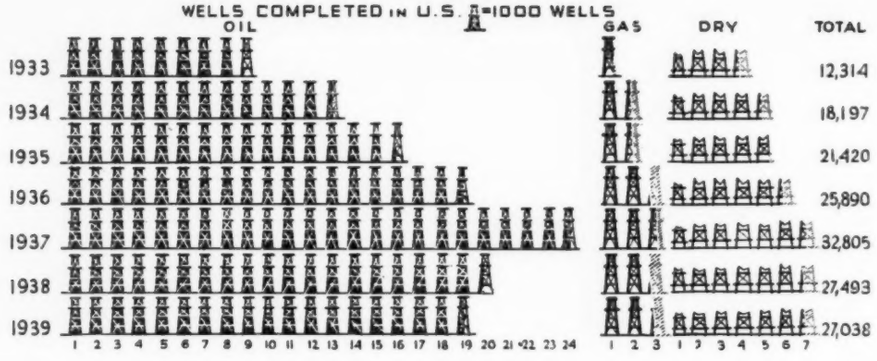
Crude Oil Run to Stills
(In barrels of 42 gals.)

Year	
1933	861,254,000
1934	895,636,000
1935	965,790,000
1936	1,068,570,000
1937	1,183,440,000
1938	1,165,015,000
1939 (est.)	1,238,939,000

Production of Crude Petroleum
(In barrels of 42 U. S. gallons)

Year	United States	Rest of World	Total World
1933	905,656,000	536,344,000	441,000,000
1934	903,065,000	613,380,000	1,521,445,000
1935	996,596,000	658,092,000	1,654,688,000
1936	1,099,687,000	702,099,000	1,801,786,000
1937	1,279,160,000	762,878,000	2,042,038,000
1938	1,214,335,000	753,332,000	1,967,687,000
1939 (est.)	1,260,099,000	817,532,000	2,077,631,000





production. The bill has been denounced as unnecessary by many in the industry and by state officials, and was protested in a resolution of the American Petroleum Institute's board of directors in November.

Large increases in the volume of petroleum products used by United States consumers, particularly by motorists and by industry, again called attention to the dependence of modern living standards upon petroleum. The 1939 consumption of all petroleum products averaged about 1,725 gal. for every family in the country. More gasoline, light fuel oil, kerosene, and lubricants than ever before in the industry's history were manufactured and sold to consumers; only residual fuel oil of the major products showed consumption below the previous high, although the demand was substantially above 1938.

Motor-fuel production in the industry's 445 refineries, which ran 1,238,959,000 bbl. of crude oil in 1939, is estimated at 596,111,000 bbl., a 7.2 percent increase over 1938; domestic consumption of motor fuel increased 5.5 percent, to 552,000,000 bbl., while exports dropped 7.9 percent to 46,163,000 bbl.; total refinery demand thus was 598,163,000 bbl., an increase of 4.4 percent.

An estimated 133,775,000 bbl. domestic consumption and 33,407,000 bbl. export demand for gas oil and distillate fuel oil compares with total 1939 refinery production of 162,480,000 bbl. Increases of 13.9 percent in domestic consumption, of 12.7 percent in export demand, and 7.1 percent in production over 1938, are indicated. Chief users of this light fuel oil, accounting for about 70 percent of the domestic total, are automatic domestic oil burners; it is believed 1,860,000 were in operation in house-heating plants in the United States at the end of 1939.

The producing branch of the industry operated at a 3.8 percent higher rate than in 1938, crude-oil production totalling an estimated 1,260,099,000 bbl. This is slightly lower than the 1937 all-time peak, however. Production in other countries is believed to have increased 8.5 percent to 817,532,000 bbl., making total world production 2,077,631,000 bbl. The proportionate share of the United States in the total dropped fractionally to 60.7 percent.

The number of completed wells was 1.7 percent under the 1938 total, but revived

Wells Completed in the United States

Year	Oil	Gas	Dry	Total
1933	8,073	923	3,318	12,314
1934	12,520	1,368	4,309	18,197
1935	15,108	1,401	4,911	21,420
1936	18,523	2,070	5,297	25,890
1937	23,678	2,695	6,432	32,805
1938	19,286	2,066	6,141	27,493
1939 (est.)	18,459	2,191	6,388	27,038

activity in the last quarter indicated an upward trend in oil-well drilling. Of 1939's 27,038 completed wells, 18,459 found oil and 2,191 struck gas.

Stocks of crude petroleum in storage at the end of the year totalled 237,825,000 bbl., down 37,133,000 bbl. from the December 31, 1938 total, and the lowest year-end stocks since 1921.

The United States continued its favorable foreign-trade balance in crude petroleum, with exports of 73,594,000 bbl., more than double the imports of 33,735,000 bbl.; 15.4 percent of the imports were in bond for reexport and so had no effect on domestic trade. The export total is 4.7 percent under 1938 while imports rose 27.7 percent.

Crude-oil prices, as indexed by the 36-degree Oklahoma-Kansas price, remained at $1.02 a barrel throughout 1939; no estimates of the country-wide average per-barrel price

Motor Fuel Demand
(in barrels of 42 gallons)

Year	Domestic Demand	Total Demand
1933	380,494,000	409,815,000
1934	410,339,000	435,025,000
1935	434,810,000	465,423,000
1936	481,696,000	510,252,000
1937	519,352,000	557,658,000
1938	523,003,000	573,112,000
1939 (est.)	552,000,000	598,163,000

are available, but it is expected to be lower than the 1938 average, $1.13.

Gas Oil and Fuel Oil Produced in U. S. Refineries
(in barrels of 42 gallons)

Year	Gas Oil and Distillate	Residual Fuel Oil	Total Fuel Oil
1933	78,920,000	237,519,000	316,430,000
1934	94,972,000	240,381,000	335,353,000
1935	100,235,000	259,826,000	360,061,000
1936	125,906,000	287,968,000	413,874,000
1937	146,706,000	312,064,000	458,770,000
1938	151,774,000	294,890,000	446,664,000
1939 (est.)	162,480,000	307,564,000	470,044,000

Wholesale prices of petroleum products again were lower than any others reported by the U. S. Bureau of Labor Statistics; the estimated 1939 index, based on 1926 as 100, was 52.0 for petroleum products compared with an all-commodity average index of 76.7.

Average retail gasoline price of 13.30 cents a gallon in 1939 was a six-year low. State, federal, and local taxes averaged 5.44 cents a gallon. Equivalent to a 40.9 percent sales tax, they obscure the industry's progressive savings to consumers. Total average cost, including taxes, was 18.74 cents a gallon.

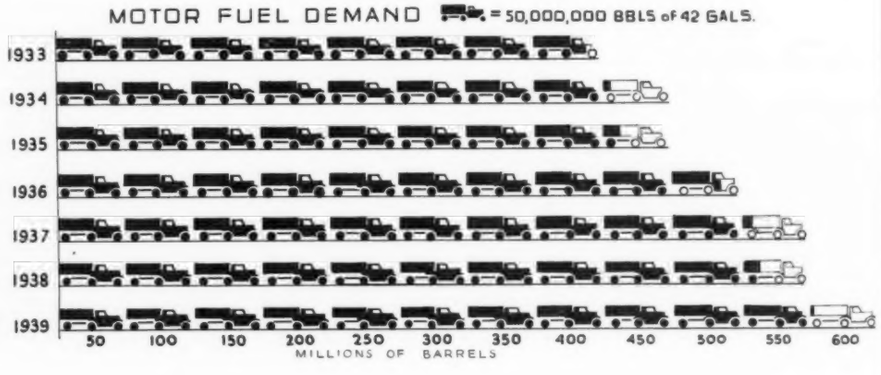
Motor Fuel Produced in U. S. Refineries
(in barrels of 42 gallons)

Year	
1933	401,591,000
1934	416,932,000
1935	457,842,000
1936	504,811,000
1937	559,141,000
1938	556,012,000
1939 (est.)	596,111,000

Refineries in Operation in the United States

January 1, 1933	372
January 1, 1934	454
January 1, 1935	435
January 1, 1936	422
January 1, 1937	423
January 1, 1938	431
January 1, 1939	435
January 1, 1940(est.)	445

Total 1939 gasoline-tax collections from consumers are believed to have reached $1,029,000,000, being the first time the total has passed the $1,000,000,000 mark. The states collected $812,000,000, the federal government $217,000,000. Other petroleum taxes, whose numbers total more than 200, are expected to raise the 1939 petroleum tax bill on the industry and its customers to $1,335,000,000, about $50,000,000 more than



Gas Oil and Distillate Fuel Oil Demand

(in barrels of 42 gallons)

Year	Domestic Demand	Total Demand
1933	64,748,000	76,172,000
1934	74,824,000	89,330,000
1935	86,018,000	102,277,000
1936	102,757,000	123,205,000
1937	116,841,000	146,970,000
1938	117,449,000	147,090,000
1939 (est.)	133,775,000	167,182,000

Residual Fuel Oil Demand

(in barrels of 42 gallons)

Year	Domestic Demand	Total Demand
1933	258,957,000	268,096,000
1934	265,547,000	279,646,000
1935	280,695,000	293,394,000
1936	307,884,000	322,319,000
1937	325,514,000	340,818,000
1938	290,065,000	307,985,000
1939 (est.)	325,384,000	343,238,000

Estimated Number of Oil Burners in Operation

End of Year	Domestic	Industrial	Total
1933	913,200	48,600	961,800
1934	1,014,100	62,900	1,077,000
1935	1,155,000	77,900	1,232,900
1936	1,355,800	96,300	1,452,100
1937	1,553,800	115,700	1,669,500
1938	1,657,900	128,000	1,785,900
1939 (est.)	1,860,000	143,100	2,003,100

Motor Fuel Prices, Taxes, and Costs

Year	Average Retail Price	State and Federal Taxes	Average Total Cost per gallon to Cons'mer
1933	$.1241	$.0541	$.1782
1934	.1364	.0520	.1884
1935	.1355	.0529	.1884
1936	.1410	.0535	.1945
1937	.1458	.0540	.1998
1938	.1407	.0544	.1951
1939	.1330	.0544	.1874

Petroleum Taxes

Year	Total Taxes
1933	$1,004,824,000
1934	1,046,149,675
1935	1,121,936,698
1936	1,183,147,498
1937	1,315,487,798
1938	1,286,114,473
1939 (est.)	1,335,000,000

Index of Wholesale Prices

(1926—100)

(U. S. Bureau of Labor Statistics)

	Petroleum Products	All Commodities
1936	57.3	80.8
1937	60.5	86.3
1938	55.9	78.6
1939*	52.0	76.7

*10 mths.

Gasoline Taxes Paid by Consumers

Year	State	Federal	Total
1932	$513,047,239	$ 62,839,827	$575,887,066
1933	518,195,712	181,125,988	699,321,700
1934	565,027,000	170,109,269	735,136,269
1935	616,851,671	172,262,481	789,114,152
1936	686,631,000	186,321,448	872,952,448
1937	756,930,000	203,025,380	959,955,380
1938	766,853,000	200,881,000	967,734,000
1939 (est.)	812,000,000	217,000,000	1,029,000,000

Estimated Annual Cost of Motor Fuel and Taxes Per Consumer

(based on average number of motor vehicles in use each year)

Year	Annual Consumption per Vehicle (gallons)	Cost of Fuel	Cost of Taxes	Total Cost to Consum'r
1925	502	$100.85	$ 10.59	$111.44
1929	619	110.92	21.67	132.59
1935	677	91.73	35.81	127.54
1937	721	105.12	38.93	144.05
1938	706	99.33	38.41	137.74
1939 (est.)	732	97.36	39.82	137.18

Foreign Trade of U. S. in Refined Petroleum Products

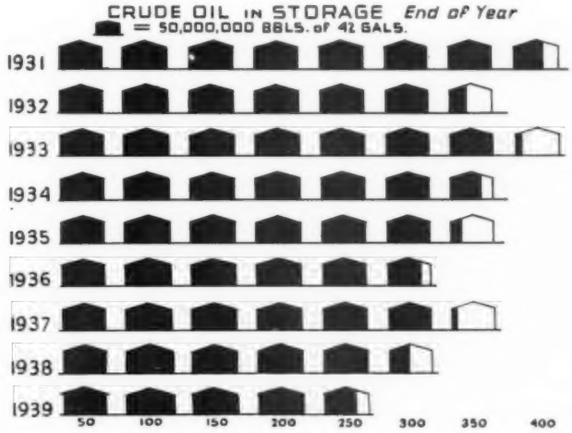
(in barrels of 42 gallons)

Year	Exports	Imports
1933	70,143,000	13,501,000
1934	73,380,000	14,936,000
1935	77,557,000	20,396,000
1936	81,687,000	24,777,000
1937	105,600,000	29,673,000
1938	116,474,000	27,896,000
1939 (est.)	117,336,000	26,014,000

Foreign Trade of U. S. in Crude Petroleum

(in barrels of 42 gals.)

Year	Imports	Exports
1933	31,893,000	36,584,000
1934	35,558,000	41,127,000
1935	32,239,000	51,430,000
1936	32,327,000	50,313,000
1937	27,484,000	67,234,000
1938	26,412,000	77,254,000
1939(est.)	33,735,000	73,594,000



Crude Oil in Storage at End of Year

(in barrels of 42 gals.)

Year	
1931	379,660,000
1932	339,715,000
1933	355,312,000
1934	337,254,000
1935	314,855,000
1936	288,579,000
1937	306,826,000
1938	274,958,000
1939(est.)	237,825,000

in 1938, and the largest levy in the industry's history. These taxes totalled more than four times the industry's earnings, and accounted for more than 10 percent of all taxes levied in the nation.

The average motorist, who used about 732 gallons of gasoline in 1939, thus paid only $97.36 for fuel, $3.50 less than he paid in 1925 for 230 fewer gallons. Tax costs in 1939, however, were four time as great, and the average motorist paid $39.82 in gasoline taxes, 29.0 percent of his total fuel bill of $137.18.

These and other statistical data of the petroleum industry, comparing 1939 estimates with records of recent prior years, are shown in the accompanying tables.

Issue of STATE vs FEDERAL Control Joined in COLE BILL Hearings

Measure not Designed to Supplant State Authority, Declares Secretary Ickes, While Admitting That in Case of Conflict Federal Views Would Prevail —Thompson Warns That Texas Will Fight Proposal to Last Ditch

PRELIMINARY sessions of the Cole subcommittee of the House Committee on Interstate Commerce which has under advisement the bill for the extension of federal authority over the petroleum industry were held in Washington during November. They were devoted to hearing representatives of the Department of the Interior and other federal officials who presented arguments in support of the bill's provisions giving the national government power to prevent waste in oil production within the states.

Following these hearings members of the committee made a field trip to the mid-continent and conducted hearings in New Orleans to receive the views of state officials. Unfortunately these hearings were cut short by the sudden death of Representative Mapes of Michigan, a member of the committee, after only two witnesses had been heard on Dec. 11. Further hearings are to be held in Washington during January at which additional testimony will be received.

Briefly the bill would establish an Office of Petroleum Conservation in the Department of Interior under the direction of a commissioner who would be authorized to determine what constitutes waste in the production of crude oil and natural gas and given power to prevent wasteful production. The bill sets forth a long list of production practices which would be considered wasteful but in the end invests the commissioner with additional discretion to make other findings of wasteful production.

Pertinent oil activities of the Federal Government would be consolidated in the Office of Petroleum Conservation. The Connally hot oil act, which Congress has extended for a period of three years, would be made permanent and its administration and enforcement placed under the new commissioner. An advisory body, to be known as a Council of Petroleum Conservation, appointed by the commissioner, would be set up to assist in an interchange of information on production methods and practices. This Council, which the sponsors of the bill believe would prove effective in broadening the knowledge and understanding of oil conservation, would be composed of nine state officials engaged in the administration of state petroleum laws, six persons engaged in the production of petroleum and three engaged in the teaching of subjects related to petroleum in educational institutions.

Although the Cole committee is far from the conclusion of its labors the hearings thus far have served to define the positions of its supporters and opponents and the arguments for and against the proposal. These have been set forth most fully by Secretary of Interior Harold Ickes who is the chief proponent of the measure and by State Commissioner E. O. Thompson of Texas who presented the views of his state at the hearing in New Orleans.

While it has been contended that the bill is not intended to supplant state regulation, Secretary Ickes acknowledged that where conflict in authority arises it is the purpose of the measure to make federal authority prevail. This admission came at the end of the Washington hearings and after committee members had frequently projected the suggestion that the fundamental idea of the bill seemed to be to supplant state with federal authority. Mr. Ickes said:

> "The purpose of the bill is not to supplant state authority with federal authority. Instances might arise in which there would be elements of conflict between these authorities and, if the matter should reach a point where determination were necessary, it is the intent of this bill that the federal authority would prevail.
>
> "It is my opinion, however, that such instances of conflict would be infrequent even at the start and more so as the provisions for coordination become effective. In most instances the provisions of this bill would be exercised in situations where state authority had not been applied or where its application was being withheld because of pressure of circumstances beyond the control of those in immediate charge of the state laws.
>
> "In instances where state orders will have been issued but investigations under this bill would show that they were ineffective in preventing avoidable physical waste as defined, it would be necessary to have definite proof of that fact. Such proof would have to come after, and not before, the state order had been applied and ordinarily would be sufficient to convince the oil producers and the state authority of the need for modification of the orders of the latter. The point at issue in such circumstances would not be trivial, but would be fundamental and definitely recognizable as such. Such a conflict might arise in a field in which there would be positive evidence of a substantial decline in reservoir pressure, excessive gas-oil ratios, and an approach to the critical point at which gas in solution with the oil could escape underground.
>
> "If the producers in such a field then should demand that the state authority allow them to produce more oil and the authority should yield and permit increased withdrawals, even though it were evident such action would aggravate the already wasteful practices, then the provisions of the bill should be applied, even to the point of legal action against the producers."

On the other hand Secretary Ickes emphasized that the bill does not authorize the federal government to limit, on the basis of demand, the oil production of the United States, or of any state, field or well. Further it does not permit the federal government to prevent or correct discriminations among property or royalty owners or producers within a single pool or between different pools within a state which may arise in the allocation of production among fields and wells by state authority. Nor does it, he emphasized, provide that the federal government should regulate refining or marketing practices.

Secretary Ickes listed the five agencies in the Department of the Interior the oil activities of which would be brought under the proposed Petroleum Conservation Office as the Bureau of Mines, engaged in studies of petroleum engineering; Geological Survey, Office of Indian Affairs, General Land Office in connection with oil and gas leased on public, Indian and naval petroleum reserve lands; and the present petroleum conservation division including the Federal Tender Board which assists in the administration of the Connally law. In the aggregate, these divisions expend annually approximately $1,400,000 and have nearly 450 employees in Washington and the field.

Before he completed his statement Mr. Ickes told the committee that he had asked the Solicitor of the Interior Department to prepare a complete brief on the constitutionality of the bill.

David Huston, assistant solicitor of the Interior Department had previously told the committee under the questioning of Representative Wolverton of New Jersey that while the measure is not designed to give the federal government full control over oil production, the federal authority would be superior to that of the state regulatory agencies whenever it was found that state orders do not adequately prevent waste.

Hugh D. Misser of the Geological Survey, who submitted a report of the estimated reserves of petroleum told the committee that the figures were "only a guess."

"I cannot give you any figures in terms of years as to how long our petroleum supply will last because we do not know," he said, adding that the known reserves of oil as of January 1, 1939 are somewhat in excess of 17,000,000,000 bbl.

H. A. Breakley, of the petroleum economic division of the Bureau of Mines, in charge of the monthly forecasts of demand upon which state proration agencies base their allowables, detailed for the committee the methods used in reaching the forecasts. He told the committee that generally the figures are close to actual demand, although at times they lag slightly behind the demand. He said that state regulatory officials had informed the Bureau that they would find it very difficult to fix allowables without the regular estimate.

A suggestion of the advisability of complete embargo on exports of American petroleum was advanced by Representative Wolverton after Rear Admiral H. A. Stuart, director of the Naval Petroleum Reserves discussed national defense needs, estimating that the Navy would require at least 50,000,000 bbl. a year in wartime against peacetime requirements of 9,000,000 bbl. Before Admiral Stuart left the stand Chairman Cole assured him that irrespective of what action was taken on the pending bill nothing would be done to interfere with the Navy's control over its own reserves. Much of Admiral Stuart's testimony dealt with the Navy's plan to take title to the submerged oil deposits off the coasts of California, Texas and Louisiana, a project not involved in the Cole measure.

Commissioner Thompson of the Texas Railroad Commission and Jerry Sadler, junior member of the Commission, were the two witnesses heard at New Orleans. Commissioner Thompson, who is chairman of the Interstate Oil Compact and a leading advocate of the right of the states to regulate oil production, took the position that passage of the bill would mean the end of control by the states over their petroleum affairs.

The Cole Committee in Louisiana: left to right, E. J. Layton, clerk; Allen H. Perly, aide; Rep. E. A. Kelley; the late Carl Mapes; seated is Rep. William P. Cole.

"The problems of overproduction that bothered us in 1934," (when the earlier Cole committee began an investigation of the industry and visited the Texas fields) said Col. Thompson, "are no longer present. Production of crude petroleum is being held strictly within the market demand. Huge overhanging surplus stocks of crude oil in tanks above ground have been reduced to 230,000,000 bbl., whereas in 1934 crude stocks were about 100,000,000 bbl. higher than they are today.

"Stocks of crude should be somewhere between 200,000,000 and 260,000,000 bbl. in order to insure uninterrupted operations. It happens, interestingly enough, that our present surplus is just exactly between those figures. Officials of sovereign American states have achieved this efficient statistical position by the use of good common sense without anyone saying 'you must do thus and so.'

"In spite of the new Illinois fields, where they have not yet agreed on a conservation law, actual production for the week of November 18 for the entire United States was some 25,000 bbl. per day less than the estimated demand. This picture of efficiency shows no need for any interference on the part of the federal government. The federal government, on the contrary, should be happy over the fact that in these days of problems and depression here is one American industry that is not looking to the national capital to be saved. Here is one industry that is not asking for any subsidy or aid of any kind. Certainly there must exist some need or emergency before the federal government would concern itself with taking over the powers of the states.

"Surely so long as the states are doing a workmanlike job there need be no federal alarm or control.

"Back in 1925, a great hue and cry went up that we were about to exhaust our petroleum supply. We had, at that time, estimated reserves of 5,500,000,000 bbl. in the United States. We have since produced and consumed or sold 11,000,000,000 bbl. and today we have 17,000,000,000 bbl. or more of oil reserves uncovered and ready to be produced as needed. We are, in addition, able today to get twice as much gasoline out of each barrel of oil. Truly, we have not run out of oil under state control."

The industry, Col. Thompson pointed out, is free of labor trouble and pays its workers better than any other major industry. The Interstate Oil Compact, he added, enables the states to work in complete harmony without the slightest compulsion. "The compact," he remarked, "has behind it the greatest power in the world—the power of enlightened public opinion. That is all the force any governmental agency needs."

The states' oil conservation effort, he added, is a hopeful sign of progress in that it brings about the intelligent use of the best engineering methods under the laws of the states through exercise of their police power to the end that the greatest ultimate recovery will be had.

"The number of independent oil operators in Texas," Col. Thompson testified, "has increased 2,000 in the past five years. This shows that they are prospering. Under proration, they no longer have any trouble finding easily available loans as low as four percent interest on 36 months' time. Banks know the oil will be produced at a proper rate and the fields will not be ruined by over-production. Oil loans have changed from the classification of speculative to perhaps the most desired and dependable security a bank could lend its money upon."

Of Texas' 254 counties, he pointed out, 134 now produce oil and exploration is going on in 100 more. "Oil is the very lifeblood of Texas. Naturally, we feel we would be recreant to our trust if we did not guard jealously the control of the state's greatest asset.

"I can see no need whatever for the federal government to pass any further laws. Reserves are constantly being built up; the consumer gets a constantly better product at a constantly cheaper price; the states are working in harmony; production is in balance with consumption; over-production has been stopped and waste is being increasingly prevented.

"I do not admit that the federal government could do a better job. If it could do a better job, I strongly believe it is far better to stay by the American form of government and keep our control close to home."

Answering questions put to him by the committee, Col. Thompson said that of Texas' 89,000 wells, 57,000 are pumping and the balance are flowing. Gas waste in the Panhandle has been reduced 93 percent during the past five years. Every Texas field is prorated and each well is selling oil. Government agencies, like the Bureau of Mines, in Col. Thompson's opinion, should remain "mere fact-finding agencies with no regulatory powers over industry."

(Continued on page 52)

OUTLOOK for Improved Production Technique

By Ernest K. Parks

SCIENCE, as applied to the world petroleum industry has outrun necessity. The proof is over-production. But technical progress continues, by virtue of competition. The result is to make oil easier to find, cheaper to capture, and more valuable in use. With crude made continually more available, less is needed to supply the same quantity of the major product, gasoline. In this situation it would seem that by far the most helpful scientific aid to the industry would be to discover some appreciable uses for petroleum in addition to its primitive service for burning and lubrication. Of course there are hundreds of specialties, but these are unimportant in quantity, and although some marvelous product were invented it would probably be necessary to sell it in competition with a present commodity.

Selling brings up the real problem, and one by no means peculiar to the oil industry. Simply stated, some group of people depend upon a certain commodity for existence. They have more product than other people can use or are able to purchase. This problem is attacked in two ways; by developing the market, as for example "oil for the lamps of China" or by improving the buying power as attempted by the schemes of commerce. These are not altruistic. The supplier of one commodity is not concerned over the displacement of another. Competition decides. The victor prospers, the other fails. Examples are tragic, but interesting and instructive. The fixation of nitrogen bankrupts the people of Chile; cellulose textiles destroy the silk industry of Japan; the Japanese in turn resort to cotton goods manufacture, Englishmen go into idleness, nations of rich suppliers or skillful artisans find their economy revolutionized within a generation. Then there is a design for war, with which half the world is now aflame, and petroleum is vital to the conflagration.

We, who have oil to sell, cannot rejoice over the prospect of a sale for fuel while our customers destroy one another, and others conserve all their resources to provide for defense or to counteract the loss of trade with belligerents. We must find some other more constructive solution, especially since the anticipated war sale has not materialized.

Technicians of the producing phase of the oil industry will not solve the really serious problem of excess supply. They will intensify it. Chemical and physical research in petroleum refining on the other hand, faces a real frontier of industrial progress. Their accomplishments may mean distress to some other industry, as for example the large scale production of synthetic rubber, but in this struggle for existence the only mercy is a reciprocal agreement.

At this stage one might speculate as to the future if the industry were regulated to the extent that exploration ceased in the United States. First the various pro-ration authorities would forsee the end of their troubles. Next, there would be thousands of workers and professional men out of work, and more millions of idle capital. Then there would be an exodus of men and money to other countries. There is much room: Brazil, New Zealand, Peru, Canada, Indo-China and the presently less propitious but sizeable Africa and Australia. In a few years our domestic rate of output would become adjusted to local demand, but meanwhile the powerful force of present knowledge would have developed a world supply with which we could not compete, and there would be an enforced conservation of petroleum, so ardently advocated by many leaders today.

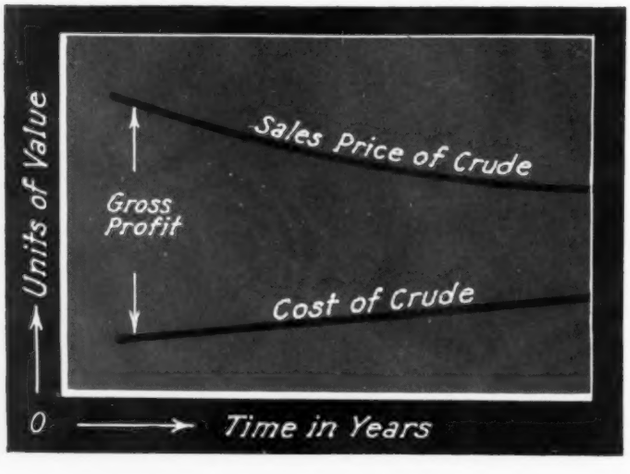


Figure 1

This forecast, so briefly outlined, might not be detrimental to the United States. During the transitional period there would be hardship for some, but after adjustment the industry might grow accustomed simply to providing for current needs with a permissible allowance for the future and never feel the permanent loss of the export business. There would, however, be one great sacrifice, to wit: Freedom of enterprise. Then there would be no progress to report in the annual issues of our journals.

Instead of jumping from the frying pan into the fire, why not face the problem squarely and take courageous measures to correct evils? Let the scientists, the technologists and the engineers investigate, develop and apply knowledge in accordance with their respective professions, but let management turn its mind to managing the industry.

There is not one problem in the science and art of exploration, development or production which deserves the concern of directing heads of the industry. At this moment, and after this violent statement, it is in order to inspect a few simple graphs.

Without resorting to statistics, any informed manager knows that the gross profit of oil production enterprise is diminishing as illustrated in Figure 1. To restore the spread he must either receive a better price or lower the cost. In order to obtain a better price there must be either an increased demand or a decreased output. Only the latter receives much public attention.

With decreased output something radical happens to costs. They rise, guided by a basic curve which the engineer knows as an hyperbola. For example: A well carries a daily charge of $10. It produces 10 bbl., the cost per unit is $1; it produces five bbl., the cost is $2; it produces two bbl., the cost is $5, etc. Savings which may be effected in lifting costs cannot compare with such a trend in overhead charges.

Once more, decreased output means decreased present worth and whether one credits this factor at its face value, or scorns it, the effect is as shown in Fig. 3. If, for example, one receives one bbl. at the end of each year for ten years the four percent worth today of that accumulation of ten actual barrels is only 8.11 bbl., a discount of almost 20 percent. For 20 years the present worth of 20 accumulated barrels is 13.6 bbl., a discount of 32 percent.

Thus restriction raises costs, and decreases present worth.

Does curtailment cause a rise in price to offset increased cost? Or does it maintain the price? Pogue[1] says "During the period of proration, 1927-1938, the price of crude oil has averaged $1.04 per barrel, with a range in annual averages of 65 cents to $1.30. There is

[1] Joseph E. Pogue, Economics of the Petroleum Industry, World Petroleum, Nov. 1939.

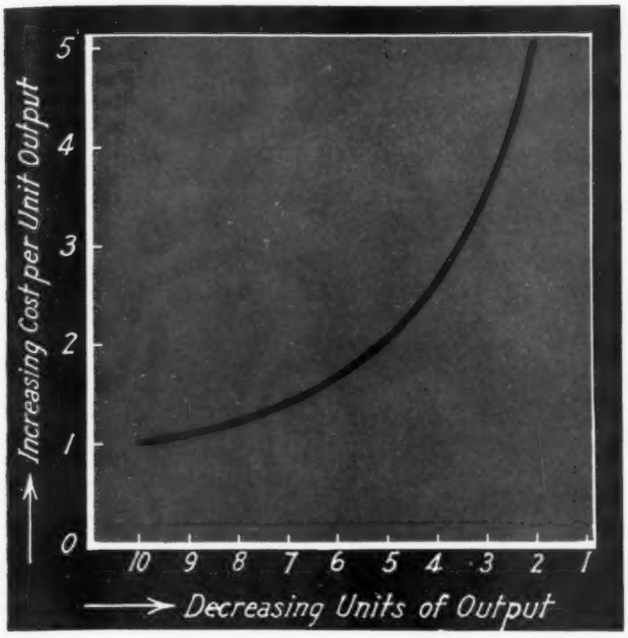


Figure 2

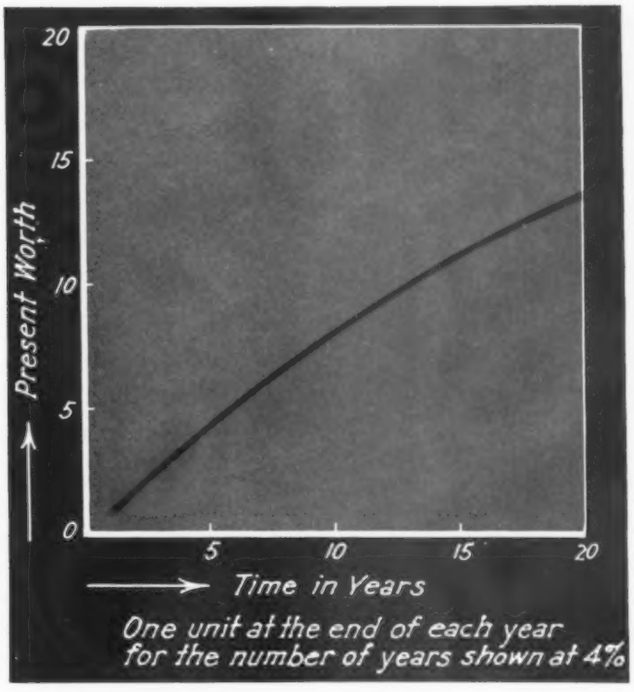


Figure 3

a predisposition in many quarters to judge the success or failure of proration by the price resultant. This view overlooks the functional nature of prices. Even with proration affecting supply, price fluctuations should play an important role in maintaining equilibrium. It would be a mistake to expect proration to create a stable price under all circumstances; on the contrary, a flexible price should be invoked to maintain the effectiveness of proration." Apparently there will be no great relief from this source.

Then we turn to progress in the art. What can we expect from that? The answer is less cost of exploration per barrel (if success in actual finding keeps up), less cost of drilling, and less cost of actual lifting, and more oil. Regardless of whether the consequences are economically and socially favorable, it is of passing interest to summarize recent developments in the various branches.

Geophysics is, of course, the most effective tool of the exploratory geologist, for it is the geologist who fundamentally conducts the search for new fields. In this respect Gutenberg[2] says: "The relationship between geology and geophysics has been discussed frequently. There can be little doubt, however, that geophysics and geology must cooperate to get a maximum of results. This is a fact from the viewpoint of geology as well as of geophysics, and for problems concerning the structure of the earth's crust as well as for investigations concerning local problems of economic importance." An interview was had with Dr. Gutenberg to discuss new developments in geophysics, but he stated that there was nothing outstanding to report as an accomplishment of the last year.

In a review of the geophysical situation, Kelly[3] states, "The geophysical scene shifts and alters, the emphasis changes, and new possibilities loom, but the tendency is always towards widening the field and deepening the analytical penetration. . . . One of the striking features of recent geophysical work in the oil fields has been the marked decrease in the number of seismic crews employed. Although the percentage of company crews is believed to have increased appreciably, the sum total has fallen sharply, as shown by the figures for the Gulf Coast area. About two years ago probably over 100 seismic parties were operating there, whereas now there are only about 35. This decrease may be partly due to the low prices of petroleum, with a consequent reluctance to spend money to increase crude-oil reserves, but more probably to the fact that reflection and refraction shooting have been carried on so extensively that they have been applied to a large proportion of the areas in which they may reasonably be expected to succeed. . . . As far as the instruments and methods are concerned, little new has been introduced in 1939."An excellent review of the subject is submitted by Herbert Hoover, Jr., of the United Geophysical Company of Pasadena, Caif,. in a personal communication to the author dated January 5, 1940.

"The progress of geophysical exploration during 1939 has been marked by the continuation of two significant trends which were noted during the previous year. First, there has been a very substantial increase in petroleum geophysical exploration outside the United States, and second, there has been steady technical progress in all of the various branches of the industry.

"Activity within the United States has continued at approximately the same levels as in 1938. There has been some shifting of emphasis between major geographical areas, but on the whole, the level of activity would appear to have remained at about 60 percent of the peak reached during 1936 and 1937. There has also been some shifting between the various methods employed. Seismograph remains as the best method of obtaining accurate and detailed information on any given area, but the gravity, magnetic, and electrical methods are finding increased application in reconnaissance problems. Geochemical methods of soil analysis appear to hold considerable promise for the future, but the general consensus among geologists is that a large amount of work still remains to be done before the method can be removed from the experimental class.

"The continued increase of geophysical activity outside the United States is exceedingly significant when considering the future of petroleum economics in the world at large. It is not confined to any one particular area, but has spread to every quarter of the globe where any hope of finding oil is believed to exist. American organizations are carrying on exploration in such diverse regions as Great Britain, Germany, Roumania, Egypt, Persia, Iran, Arabia, India, Borneo, Java, Sumatra, Philippine Islands, New Zealand, practically all of the South American countries, and on many of the islands in the Caribbean. It would seem to be a fairly obvious conclusion that in the next few years this intensive exploration will result in some major shifts of the world's sources of petroleum.

"In California, during 1939, the seismograph has continued to be the most popular method used in geophysical exploration. A limited amount of gravity, magnetic and

[2] B. Gutenberg, Geophysics as a Science, "Geophysics," July, 1937.

[3] Sherwin F. Kelly, Chairman, Committee on Geophysical Methods of Exploration, A. I. M. M. E., Mining & Metallurgy, Jan. 1940, p. 41.

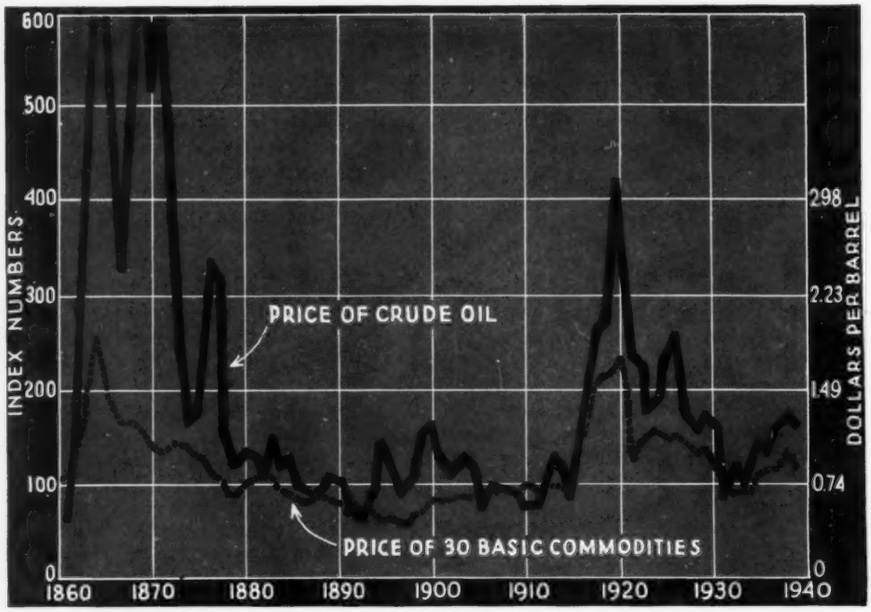


Figure 4

electrical work has been carried on by a few organizations, but only about two or three parties have been in operation. The nature of the geological problems involved undoubtedly accounts for the fact that seismic methods are used the most. The structures have generally proven to be deep and of low relief. Some work has been undertaken in applying geochemical methods, but in most quarters it is still regarded as being highly experimental.

"No spectacular improvements have been made during the year in seismic prospecting, but nevertheless steady and appreciable progress has been made toward greater accuracy and detail. The importance of accurate velocity information, particularly where the gradient changes rapidly across anomalous areas, has proven of extreme importance in many cases. In at least one instance the application of such information turned a flat terrace into an actual reversal with appreciable closure, while in several others the amount of closure at first indicated was substantially increased by proper interpretation.

"The interest in accuracy and detail has also accounted for the general adoption of the 'curved path' method of interpretation. At the beginning of the year only a few organizations were using it, with greater appreciation of accurate velocity information, it is now in general use. For the same reasons, an increasing amount of shooting is being done, using various methods of obtaining complete coverage on the sub-surface. To facilitate this type of work a larger number of parties were in operation using new types of instruments with from 20 to 24 traces, and employing from 50 to 100 seismometers each.

"Seismic surveys were generally carried to depths of 20,000 ft. or more, with apparently excellent accuracy, while good results to 30,000 ft. or deeper were not uncommon where the sedimentary section had sufficient thickness. Ability to obtain reliable reflections from these depths has required a large amount of research and development in shooting technique and instruments, and is a good indication of the continued technical progress in the industry.

"The number of seismic parties in operation has been dropped from approximately 35 to 20 during the year. This has been partly due to economic reasons within the petroleum industry itself, including more severe proration, and partly as a result of the fact that numerous areas have been condemned temporarily, at least, as a result of the surveys already completed. An increased activity in exchanging information between the various oil companies was also noted, and unquestionably contributed to the decrease in the number of parties in operation, although some saving in exploration costs has thus been effected.

"It is interesting to note that most of the oil companies now have geophysical personnel as a permanent part of their geological staff. Their principal work is the intensive re-interpretation of geophysical data. This permits a more thorough evaluation of the results than is possible by the field crews in their routine operations. It tends to bear out the writer's contention that it is the geologist and not the geophysicist who finds new oil fields. This philosophy requires that the geophysicist must provide the geologist with the finest tools obtainable, in the form of field technique and instruments. Each must have a thorough working knowledge of the other's sphere. But it is still the geologist who must locate the areas to be worked, outline the nature of the problem to be solved, and evaluate the final data in the light of all other available information."

The outstanding subject of drilling procedure today is economy. The first thought is the simple one. Reduce the bore hole size and thereby reduce the casing cost. Some operators favor slim holes because they have drilled in places where the practice was a success, others resist the movement because they either have different conditions of drilling and reservoir penetration or are so equipped with machinery that the small holes do not result in the claimed cost reductions. This subject was sponsored by the California Drilling and Production Practice Committees of the A. P. I. in 1939, and results of an inquiry presented by the author[5] at the Chicago Meeting. The discussion which followed indicated that, as found in California, there is by no means a convincing conclusion available at this time. Slim holes may cost less in some circumstances, but others vigorously led by Uren, insist that large holes have a decided advantage in production performance, the evaluation of which will offset the larger first cost.

The question of proper size of hole with respect to economical drilling, and casing installation, is not one to be settled on a national scale. The factors are many and complex, and are very difficult to evaluate. The problem is none the less fundamental and deserves continued study—not as an entity but with respect to machinery, drilling time, hazards, investment in casing, and production factors. These last are the difficult set of unknowns, but in view of the fact that they involve the rate of flow of oil and gas mixtures through porous media, the effect of gravel packing, the efficiency of perforated liners, the drainage radius of a well, and other such basic factors, the size of hole problem is a very inclusive subject, warranting the best of talent.

Another item of drilling is nothing new. It's mud. But current practice is new. Appreciation of intelligent use of correct mud is growing to such extent that it is common California practice to have an engineer delegated to the exclusive job of supervising the mud. He works with the administrative staff and also with the crew and obtains assistance from the chemical and physical laboratories. Wells are being drilled for thousands of feet in open hole, whereas but a short time ago protective strings were landed prior to water shut off points. Thus mud is a competitor of steel and the saving in casing costs returns a handsome dividend on the expense of mud supervision. The cost of mud itself has been reduced until now deep holes of some 10,000 ft. are drilled with a mud cost of only $3,000 or even less, as compared to some excessive costs of $30,000 and a previous normal of about $10,000.

Mud is also being used in prospecting and as a guide in routine development. Continuous sampling and analyzing not only assist in mud control but also disclose facts as to oil and gas indications. Special instruments and an organized service are available to operators.

Derricks grow higher, wider and roomier with bulges to take care of the great amounts

[5] E. K. Parks, Effect of Varying Well-Bore Diameters in California Reservoirs, American Petroleum Institute Nov. 17, 1939.

CORRECTION

During the printing of the four color map of Venezuela that accompanied the December issue of World Petroleum, a part of the red plate, which showed the oil features of the country, broke off. As a result, some of the issues contained maps which did not show the Jusepin, or Quiriquire field, the pipe line from Jusepin to Caripito, or the Caripito refinery in eastern Venezuela. The editors deeply regret this accident and will be glad to mail corrected copies of the Venezuela map to subscribers who find that these important fields, pipe line and refinery have been omitted from their copy. Requests for corrected copies should be directed to World Petroleum, 95 River Street, Hoboken, N. J.

of drill pipe now racked in deep well drilling. Rotary table speeds are increased to 700 r.p.m., and then decreased again when failures of drill pipe begin to appear, so the drilling speed problem is not yet solved. Casing economy has scaled down the safety factor in use by some operators. Failures have come to light, and hence the conservatives feel vindicated, but there is a lively interest in joint strength. This means that we shall hear more of various types of couplings.

Countless small improvements in machinery and new appliances for recording performance, such as the rate of penetration chart, and special services and tools for conditioning and inspecting drill pipe all lend their effect to increasing efficiency. It is to be regretted that space does not permit a detailed list of worthy refinements offered to the industry during the year, because it is appreciated that many of these are the result of years of study and thousands of dollars of development cost. The petroleum producing industry is deeply in debt to a host of conscientious and progressive suppliers who have made vital contributions to the art.

Portable outfits operate successfully in the territories where drilling is easier and not so deep as in California, but in this state the standard practice remains with substantial foundations of concrete and steel, permanent derricks (sometimes skidded to new locations), and heavy draw works and auxiliary equipment. There is one interesting local application of portability which follows an idea advanced by Wilhelm[6] several years ago; that is, to mount a derrick on wheels and run it on a track from well to well. True, this is not being applied to drilling, but is actually employed along the Pacific Coast at Huntington Beach, California, to service producing wells which are 4,500 ft. deep. This example is a good illustration of imagination turned practical. Perhaps the sea-going outfits of the Gulf-coast, which are the most spectacular examples of portability, were once likewise purely imaginative, and anyone who sees them should be inspired to make an occasional departure from orthodox thinking.

At this point, therefore, it is suggested that there is too much coddling of favorite ideas of users of drilling and production equipment. The result is a mixed assortment of drawworks, hoists, engines, pumps, pumping units, gears, and a long list of other material, much of which is practically custom built or custom-altered to suit some single engineer or superintendent. This idea is not radical. Standardization, as so far accomplished is hailed as the greatest engineering achievement of the American Petroleum Institute. Mass production is the foundation of the industrial success in the automotive industry. We have excellent precedents. Why not attempt to obtain benefits of low cost production of oilfield drilling and producing machinery?

The technique of oil lifting has been revolutionized. The old measure of ability of a production foreman is gone. The family decline curve has disappeared. "Downtime," is no longer a measure of inefficiency. Cost control is upset. New standards have come to change the personnel, methods, and machinery of production. The situation may be tabulated.

CHANGE IN FIELD PRODUCTION PRACTICE

Factor	Past	Present
The Object	Maximum rate at lowest cost per barrel	Allowed rate at lowest cost
Cost Control Unit	Cents per Barrel	Dollars per well-day
Well Operation	Maximum number, continuous production	Minimum number for required time
Equipment	Maximum capacity	Adjusted to small rate
Personnel	Skilled in pumping, well cleaning, and repair work	Experienced in general field work, conscious of high pressure conditions
Required Supervision	Constant and vigilant	Occasional and cursory
Engineering	Aimed at maximum equipment output	Strives for efficient reservoir performance
The Index of Performance	The rate-time decline curve	Pressure remaining in the reservoir, as compared to volume of oil and gas extracted
A Good Well	A record breaking producer	A great pressure back of a small flow bean.

Examination of these factors, explains at once the entirely new conception of progress in production practice. Whereas equipment was the means to a former object, the current medium is through reservoir control. Like the oil finders, the equipment suppliers have outdone necessity, and now engineers seek devices to conserve pressure of the oil bearing reservoir—instead of using appliances to exhaust that pressure quickly. The inventive talent turns to subsurface packers, valves, flow regulators, differential pressure chambers; small capacity, deep well pumps; and selective zone devices to regulate the portions of the well which shall contribute to production of oil and gas together or separately. Wells are tending too deep for rods and hence concentrated attention is given to prolonging natural flow, to efficient gas lift, and finally to electrical sub-surface motors, and fluid transmission of power to hydraulic pumps. The rod pump is with us always, and improvement continues with the aid of metallurgy, machine design, hydraulic studies[7], and well performance tests, using the sub-surface dynagraph[8], the various surface dynamometers, the depth pressure recorder, and the sonic fluid level finders known as "Depthograph[9]" and "Echo-Meter[10]."

The great unknown, however, is reservoir performance. Progress proceeds by degrees, here and there, as knowledge is accumulated. Field experiments are undertaken and practical demonstrations are made. The basic variables are pressure and volume. A most recent contribution to scientific literature is by Sage and Lacey[11], who have summarized their many monographs in "Volumetric and Phase Behavior of Hydrocarbons."

The American Petroleum Institute has a national committee on "Primary Pressure Control[12]", and they plan to make a nation-wide study of the behavior of oil and gas reservoirs as operated to use the natural energy efficiently, including methods of pressure maintenance by gas injection. Progress in this field will come through the channel of research and experiment; not through equipment, which is of relatively minor importance because of the excellence already attained.

Sub-surface investigations of reservoir characteristics of pressure, temperature, and physical constitution and content of the porous rocks is world wide, but curiously enough, is currently sorely neglected in some quarters. One reason for this is that the subject is complex, its value has not been easily appreciated, and those trained to cope with the problem are relatively few. The cost of the work appears large to some operators in view of their conception of its application, notwithstanding the enthusiasm of those who have profited so handsomely by use of fundamental production engineering.

But perhaps those who fail to delve into depth pressures are leaders in some other phase of the world petroleum problem. Subsurface mysteries are a challenge to all concerned with efficient exploitation. Some enthusiasts would place the necessity for reservoir knowledge at the first of the list of required work, but while technical men struggle with this investigation others must face the even less tangible and more formidable obstacles which now stand in the way of progress.

[6] V. H. Wilhelm, Petroleum Engineer, The Texas Co., Los Angeles, in verbal discussion before the Program Committee, 1937, A. I. M. x M. E.

[7] M. G. Arthur and E. K. Parks, Report on API Pump-Performance Experiment, American Petroleum Institute, Preprinted for the Chicago Meeting, Nov. 1938; Enlarged, reprinted, and incorporated in a final report by E. P. Tallant, Drilling and Production Practice, A. P. I., 1938, p. 217-248.

[8] Walton E. Gilbert, An Oil-Well Pump Dynagraph, Drilling and Production Practice, A. P. I., 1936, p. 94.

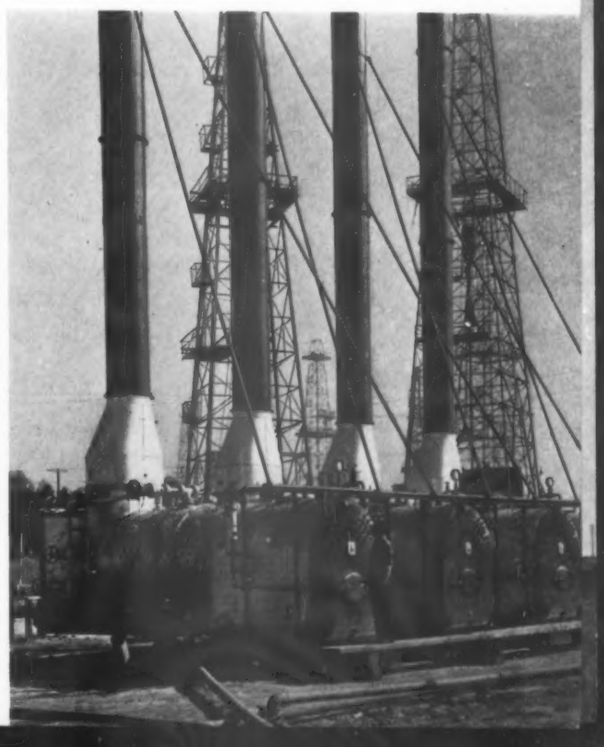
[9] C. P. Walker, Determination of Fluid Level in Oil Wells by the Pressure Wave Echo Method, Petroleum Dev. X Technology, A. I. M. & M. E., 1937, p. 32.

[10] J. J. Jakosky, Bottom-hole Measurements in Pumping Wells, Petroleum Technology, I. A. M. & M. E., May May, 1939, p. 1.

[11] Bruce H. Sage and William N. Lacey, title quoted, Stanford University Press, 1939.

[12] Committee Chairman, I. S. Salnikov, The Carter Oil Co., Tulsa, Oklahoma.

"Countless small improvements in machinery and new appliances . . . . all lend their effect to increasing efficiency"



Looking at the Gasoline of Tomorrow

By Dr. O. W. Willcox

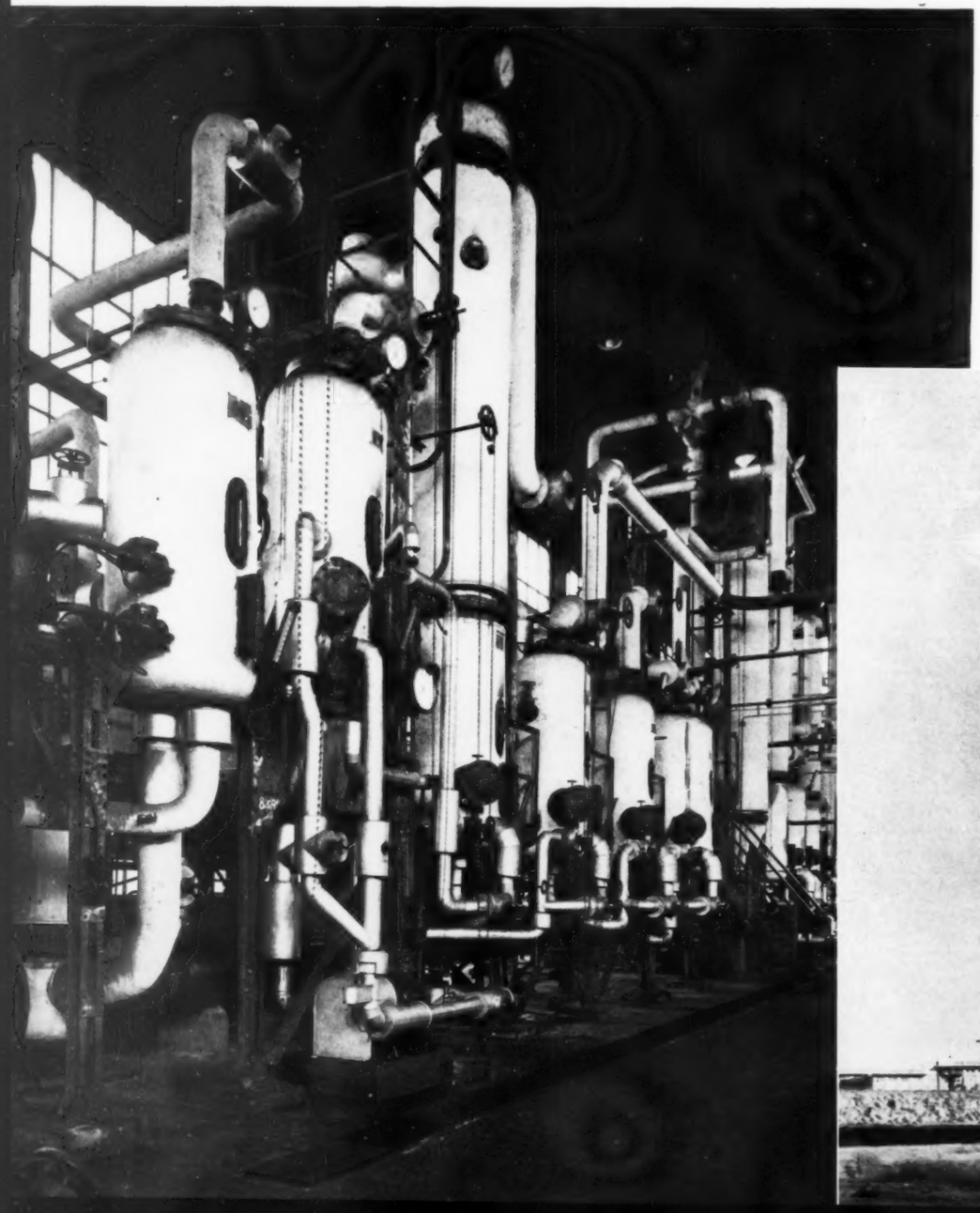
Greatest Conservation Movement in Oil Industry Lies in Efforts of Petroleum Refiners and Engine Builders to Utilize More and More of Potential Power in Each Gallon of Fuel.

ALL trends in petroleum refining, as in every other industry, converge on the one object of getting the most out of the raw material at the least expense. When we come to discuss trends in oil refining from that angle it is natural to inquire if there is a limit to what is the very most of value that can be got out of a barrel of crude petroleum.

This question was brought up for discussion at the November, 1939, meeting of the American Petroleum Institute. There is conclusive thermodynamic evidence that the actual mechanical energy contained in a gallon of gasoline is equivalent to 99,000,000 foot-pounds. Translated into more concrete terms this means that one gallon of gasoline, if all its potential power could be utilized, would drive an average automobile 450 miles. Stated somewhat differently an average filling, 14 gallons, would be sufficient for a journey of 6,300 miles at 20 miles per hour on a perfectly level road. Or this limit to the absolute energy of gasoline may be related to the question of petroleum reserves. Speaking in approximate terms, if it requires one gallon of gasoline to propel the country's automobiles an average of 15 miles, and if there are reserves enough to last for 15 years at that rate, then if the efficiency of gasoline were raised to the limit these same reserves would last for 450 years.

It is needless to say that while this is a perfectly real and visible limit it will be a practical impossibility to attain it fully. Roads are never perfectly level, losses of energy through friction, heat radiation, wind resistance and other factors can never be wholly abolished. But while it is certain that these opposing factors will never be entirely overcome, it still remains true that they can be made smaller than they are now; and in proportion as they do become smaller a greater proportion of the latent energy of gasoline will become available. Here, then, is a place to look for a really important trend. Is the petroleum industry making any recognizable progress toward the ultimate but never-completely-to-be-attained goal of 450 miles to the gallon?

The answer is that there is a very perceptible trend in that direction, and that it will undoubtedly continue into the future. It may never get even close to the final limit, but the

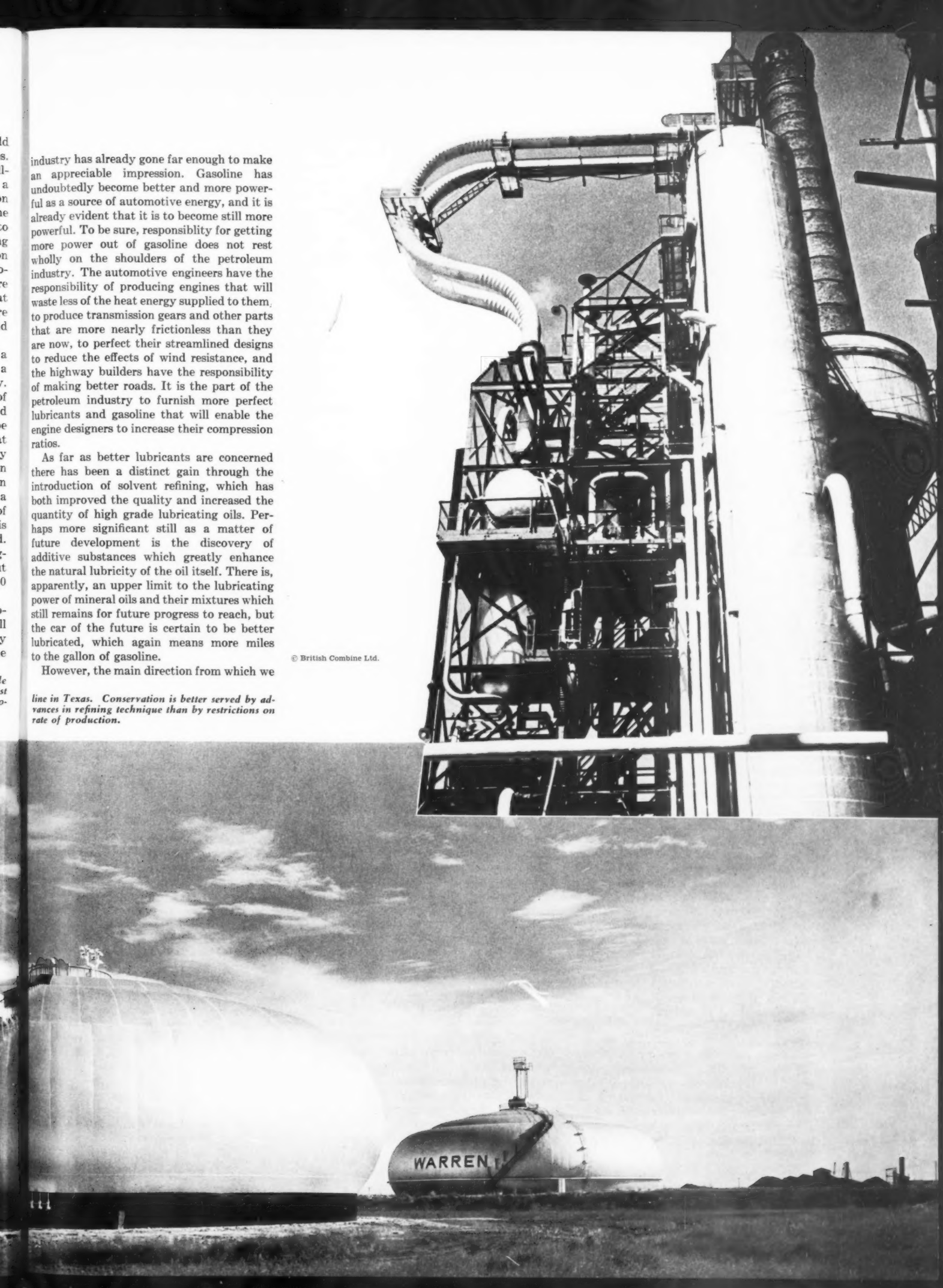


Left, British and right, Roumanian refineries, while below a photo by Robert Yarnell Richie shows latest types of low pressure storage tanks for natural gaso-

industry has already gone far enough to make an appreciable impression. Gasoline has undoubtedly become better and more powerful as a source of automotive energy, and it is already evident that it is to become still more powerful. To be sure, responsiblity for getting more power out of gasoline does not rest wholly on the shoulders of the petroleum industry. The automotive engineers have the responsibility of producing engines that will waste less of the heat energy supplied to them, to produce transmission gears and other parts that are more nearly frictionless than they are now, to perfect their streamlined designs to reduce the effects of wind resistance, and the highway builders have the responsibility of making better roads. It is the part of the petroleum industry to furnish more perfect lubricants and gasoline that will enable the engine designers to increase their compression ratios.

As far as better lubricants are concerned there has been a distinct gain through the introduction of solvent refining, which has both improved the quality and increased the quantity of high grade lubricating oils. Perhaps more significant still as a matter of future development is the discovery of additive substances which greatly enhance the natural lubricity of the oil itself. There is, apparently, an upper limit to the lubricating power of mineral oils and their mixtures which still remains for future progress to reach, but the car of the future is certain to be better lubricated, which again means more miles to the gallon of gasoline.

However, the main direction from which we



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line in Texas. Conservation is better served by advances in refining technique than by restrictions on rate of production.

may expect more-miles-per-gallon (with concomitant conservation of petroleum-reserves) is in the production of gasoline that will enable the engine designers to increase their compression ratios. As most persons who have noted the engineering features of the yearly output of new cars are aware, there has been a persistent if slow increase in this ratio; it now averages around 6.0 or a little above. Every increase in the ratio has been marked by an increase of power and more miles per gallon, which is especially noticeable if the engine is supercharged. In this connection high quality fuel means high octane number gasoline.

It is interesting to inquire how far this trend, which has a profound influence on the technology of petroleum refining and of the automobile, might be carried. Obviously, compression ratios cannot be indefinitely increased. But the practical limit is not yet in sight. It might be said also that there must be an upper limit to the octane number of gasoline, but nobody is sure that a limit on octane number exists, or if there is such a limit, where it is.

There is already evidence at hand to indicate that the limits on both compression ratio and octane number are far enough away to admit of a notable expansion in the efficiency and economy of gasoline engines.

What future developments along the lines of high compression ratios, higher octane numbers and supercharging may mean has been foreshadowed by some research, the results of which were released by the General Motors Corporation at the November meeting of the A. P. I. These results show, first, how knock is avoided by increasing octane number under increasing compression ratios; thus: approximately 69 octane fuel was required for the standard 5.2 compression ratio, about 95 octane number for 8.0 compression ratio and something better than 100 octane number for 10.3 compression ratio.

Now let us see how this relation between compression ratio and octane number bears on engine performance, and beyond that on gasoline economy and the question of petroleum reserves. The General Motors Corporation found that at the standard knockless 5.2 compression ratio an automobile would consume 12.5 gallons of the low octane number gasoline when going 40 miles an hour. When the compression ratio was raised to 8.0 with enough increase in octane number (95) to avoid knock, the mileage was 18 per gallon. When the compression ratio was further raised to 10.3 and the octane number to 100 plus the mileage was 21 per gallon. Considering only the jump from 5.2 compression ratio and 69 octane number to 8.0 compression ratio and 95 octane number, the average increase in economy at between 10 and 60 miles an hour was about 45 percent.

Here is a development of great importance to the whole petroleum problem. This 45 percent increase represents only a comparatively small bite into that 450 miles-per-gallon margin, but it is easy to see that, relatively, it is of large importance. What would an average economy of 45 percent in engine performance mean? If the number of automobiles did not increase, and if the existing cars did not run any more miles per year than at present, it would practically mean an increase of 45 percent in the visible petroleum reserves that go into the production of gasoline. Such an economy of petroleum from the known reserves would be the equivalent of more than 5,000 major (million-barrel) new oilfields! From such considerations it is not hard to recognize the petroleum technologists who produce high quality gasoline, and the builders of improved engines, as the master conservationists who are making a limited supply go decidedly much farther. Even so, the production of high octane number fuel is not the only means of adding power to an automobile. In the same line of research mentioned above, the General Motors Corporation has demonstrated that the maximum horse power of an eight-cylinder car can be nearly doubled by supercharging, and that the load economy of a small supercharged engine may be very much greater than that of an unsupercharged engine twice as large.

While these great accessions of energy and economy are now real and tangible, they are not immediately available; they will require some years for full development, but it should be well noted that they are indisputably on the way. The automobile industry is not yet keyed up to build all its engines with high compression ratios and to provide for supercharging, and the petroleum industry is not yet fully keyed to the production of 100 octane gasoline except so far as concerns aviation; and even if both industries were fully prepared in this respect the public has not the available buying power for making the change overnight, so we may expect a slow development. However, the signs are unmistakable that in no long time the production of all or nearly all gasoline for automotive use will be on the basis of 100 octane number or even more.

The joint advantages of high octane and high compression, as disclosed by the results of the above mentioned General Motors Corporation research, are simply too great to be left unexploited. The principal oil companies are making notable efforts on this line, and it seems unthinkable that the others will be behindhand in furnishing what the automobile of tomorrow will require. It is a fact that 100 octane gasoline costs the driver of an 8.0 compression car more than ordinary gasoline *in cents per gallon*, say 27.5 cents as compared with 19 cents, but it will at most cost him no more *in cents per mile*, which will give the refiner an ample margin (8.5 cents) within which to produce the high octane gasoline required for the high compression car. The economic setting for the appearance of the automobile fuel of tomorrow is thus already prepared.

Even long before the General Motors Corporation research was reported to the A. P. I. by Mr. Edgar the petroleum industry had come to realize the significance of high octane number fuel, and had begun its preparation on a large scale for the growing aviation industry. Now that quality fuel has developed to a point where it becomes of importance to the whole automotive industry it remains to note the sources that are to furnish it.

Of course, the ultimate source of all gasoline of whatever quality is still the crude petroleum of the oilfields. But the average crude petroleum contains a very small proportion of distillate that can be regarded as a high quality fuel, and this scarcity of low-boiling fractions formerly necessitated the discovery and production of enormous quantities of crude oil, which furnished a little gasoline and much residuum that could only be put to uses which amounted to a waste of valuable reserves. Then came the invention of thermal cracking, which doubled the yield of gasoline from the same amount of crude oil with a corresponding extension of the life of the available reserve. If we were still dependent on straight run gasoline we would have to run to the stills 2,400,000,000 bbl. of crude oil instead of the approximately 1,200,000,000 bbl. that now satisfy our needs; were it not for the savings effected by the thermal cracking process, instead of a 17,000,000,000 bbl. reserve we probably should now have little or no reserve at all.

Within very recent time the cracking process has entered a new phase with the introduction of catalytic cracking methods, which have opened up a number of new prospects. We will first note the bearing of catalysis on the question of how far we may stretch our petroleum reserves if new discoveries fail to keep abreast of consumption. From the conservation standpoint, current catalytic cracking processes have the merit of ability to convert an average crude oil into 80 percent of its weight of gasoline. The best managed thermal cracking process may yield at most 50 or 60 percent, the rest going to coke, tar or low grade products of little economic value. We have already credited thermal cracking with an approximately fifty-percent increase in the life of our reserves; now comes catalytic cracking to add approximately twenty percent.

Beyond that, catalytic cracking makes a further contribution to real conservation by enlarging the supply of high quality gasoline, and we have already noted that every improvement in gasoline quality (octane number) ultimately means a reduction of the draft on our reserves. The difference lies in the fact that gasoline produced by direct thermal cracking has comparatively a low octane number. To convert this low-octane fuel into quality fuel of aviation grade extraneous additions have been necessary. These extraneous additions have consisted, first, of the light liquid fractions recovered from natural gas, and more recently by compounds of high blending value (iso-octane, isopropyl ether, and quite recently neohexane), topped by more or less of tetraethyl lead. The difficulty here has been the scarcity of these extraneous materials required for making the fuel of the future generally available to all users. Now, for the first time, the petroleum industry has in catalytic cracking a means of producing high quality fuel (95 octane number or better) direct from crude oil or its residues, without resort to extraneous agents, except lead.

This does not necessarily mean that the catalytic cracking process will have anything

(Continued on page 51)

NEBRASKA Joins the Oil States

By Joseph A. Kornfeld
Consulting Geologist-Engineer

A Reflection Seismograph Survey Pointed the Way to a Shallow Oil Discovery Opening the Twenty-Third Producing State, Proving the Four-State Forest City Basin.

NEBRASKA was first proven for commercial oil production on November 1, 1939, when a rank wildcat test in Richardson county in the southeastern corner of the state obtained a hole full of oil from the Silurian limestone.

Opening the twenty-third oil-producing state, the discovery spread the extent of the Mid-Continent oilfields 85 miles northward.

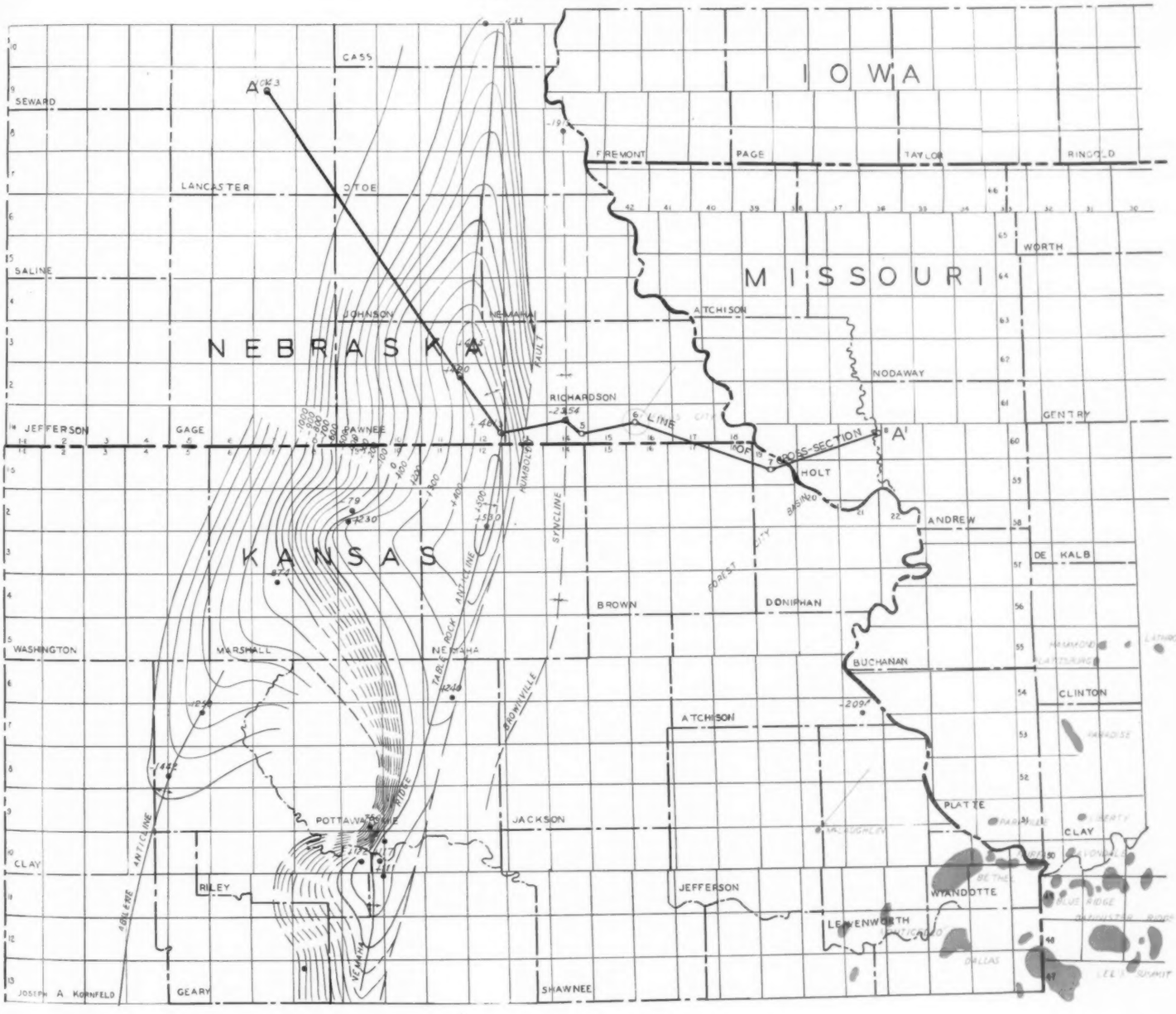
Moreover, it proved that commercial oil accumulations lie within the Forest City basin —a regional geologic feature occupying portions of southeastern Nebraska, northeastern Kansas, northwestern Missouri, and southwestern Iowa.

The new find was brought in approximately one year after a leasing campaign was participated in by both major companies and independent operators, which swept the Forest City basin. All told, more than 3,000,000 acres were leased in the four-state basin. It resulted in the renewal of approximately 800,000 acres in the Kansas-Missouri portions of the basin, of which 300,000 acres lie in Kansas.

GEOPHYSICS

The discovery was definitely the result of a geophysical survey using the reflection seismograph. However, it did not mark the first

Regional geologic map of southeastern Nebraska, northeastern Kansas, northwestern Missouri and southwestern Iowa. The red imprint carries past development in Kansas and Missouri, and indicates by arrow the discovery oil well in Richardson county, Nebraska; another arrow indicates a new Bartlesville sand discovery (gas pool) in Jefferson county, Kansas in the Forest City basin. The blue imprint carries detailed structural contours of the Table Rock anticline — northern extension of the Nemaha granite ridge, mapped on top of the Sioux quartzite of pre-Cambrian age.



Left, Nebraska's first oil well — Pawnee Royalty Company's No. 1 R. E. Boice, two miles west of Falls City in Richardson county. It marks the most northerly production in the entire mid-continent region.

Opposite page, producing in Oklahoma, International 10 ton, six wheel, truck in foreground.

introduction of this method into Nebraska: E. L. DeGolyer and the Felmont Oil Corporation of Dallas, Texas, had completed an intensive seismograph survey on the Sanford structure in Sioux county in northwestern Nebraska during the fall of 1937.

The recent seismic survey originated with Albert L. Ladner, head of the Apache Exploration Company of Houston, Texas, who carried on exploration work in Richardson county as early as May, 1938. Most reliable and consistent group of reflections came from horizons below the Silurian suggesting a deep-seated structural disturbance.

After detailing local structure, Ladner arranged with the Pawnee Royalty Company of Odessa, Texas, to assemble a huge acreage block on the anomaly indicated by his seismic work.

HISTORY

Owners of the Pawnee Royalty Company are W. A. Guinn, San Angelo, and his brother B. G. Guinn, Slaton, Texas. Their start in the oil industry dates from 1929 when they began operating as seismograph shot-hole contractors, under the name of the Guinn Drilling Company, which firm is still owned and operated by the brothers. During 1934, the brothers engaged in the lease and royalty trade, forming the Pawnee Royalty firm. Their plays spread throughout the mid-continent, extending into Illinois by 1937.

Leasing by the firm was started early in November of 1938. During the following nine months more than 80,000 acres of leases were signed up, of which 68,000 acres lie in Richardson county, Nebraska, and 12,000 acres in Brown county, Kansas, adjoining on the south.

The leasing, which paralleled drilling and exploration campaign throughout the Forest City basin, attracted the attention of major companies. At the same time Phillips Petroleum Company, Carter Oil Company and Magnolia Petroleum Company took acreage in, and south of, the Pawnee block.

Nearest reference test was a dry hole drilled in the fall of 1937 by R. F. (Bob) Garland and Arab Petroleum Company of Tulsa, Okla., No. 1 Ogle, in the southeast corner of section 9-1N-14E. It was drilled to a total depth of 3,423 ft. in pre-Cambrian rocks and encountered a showing of free oil at 2,300 ft. in the Silurian lime topped at 2,298 ft., and another oil showing at 3,100 ft. in the Viola lime; but neither showing was commercial and the well was abandoned after drilling deeper to the pre-Cambrian at 3,420 ft.

The discovery well was drilled on the R. E. Boice farm, two miles west of the agricultural town of Falls City. It was situated only three miles north of the Kansas state boundary line. At the time, the nearest developed oil production lay 85 miles southward in the Baldwin City oil pool of Douglas county.

No publicity preceded the spudding-in of the well. During its drilling progress, it attracted little field interest beyond routine coverage by the Kansas oil scouts. The well started at an elevation of 903 ft. above sea level.

The Mississippian lime was topped at a depth of 2,029 ft. (1,126 ft. subsea) and the Kinderhook shale was encountered at 2,154 ft. (1,251 ft. subsea) to 2,286 ft. representing an interval of 259 ft. for the Mississippian system. Silurian lime was topped at a depth of 2,288 ft. (1,383 ft. subsea) after cable tools originally penetrated only three feet of the formation, oil rose 80 ft. in the hole overnight; at the end of 61 hours, it had filled to the casinghead with 32.5 gravity oil. The pay was struck on November 1.

It was deepened three feet to 2294 feet.

On initial swabbing test, the well produced at the rate of 14 bbl. of crude hourly. Two-inch tubing was run into the well and swung 50 ft. off bottom, rods were run and with temporary pumping equipment the well tanked 230 bbl. of oil the first 24 hours, using a pumping stroke of 25 per minute. The following 24 hours, the discovery well gauged 130 bbl. of oil.

Meanwhile, the Pawnee firm applied to the State of Nebraska for the prize bonus of $15,000 offered by an act of the legislature for the first commercial oil well completed within the state which would produce at least 50 bbl. of oil for a period of 60 consecutive days. Governor R. L. Cochran assigned supervision of the official gauge runs to John Ainlay, director of the state motor fuel inspection division. Ainlay in turn directed W. J. Wenzl of Dawson and James Knajdl of Brainard to witness the pumping tests directly.

Accordingly two 500-bbl. lease tanks were erected and officially gauging started on November 21. The first day, the discovery pumped 58.2 bbl. of crude in the six-hour test, the well being operated only sufficiently to yield the minimum volume necessary to satisfy requirements for the daily state test. The second day the well was pumped seven hours, gauging 61.7 bbl. for the period. The crude tested 31.4 deg. Baume gravity, corrected for temperature.

Meanwhile, oil accumulated in the tank battery by previous tests had been hauled by trucks to the Searle Petroleum Company refinery at Omaha, where it brought a price of 94 cents per barrel. The Omaha refinery had contracted with Pawnee Royalty Company for the output of the well.

The first shipments of crude oil attracted considerable civic attention in eastern

Nebraska. A police escort on motorcycles accompanied arrival of the first truck shipment into the downtown section of Omaha opening a new chapter of this agricultural state.

After producing an average of 60 bbl. of oil daily for 18 consecutive days, representing an aggregate of approximately 1,100 bbl. output slumped off on December 8 below the 50 bbl. daily minimum requirement for the state oil bonus, the well had been pumped an average of six hours daily at the rate of 10 bbl. of oil hourly. The drop in daily production was caused by accumulation of cavings from 40 ft. of open hole in the Kinderhook shale overlying the Silurian lime; the 8-in. oil casing seat was 2,240 ft. The well was taken off production December 12 while a servicing crew cleaned the well out, and deepened the test one and a half feet to 2,295½ ft. at which depth the cable tool bit was in porous, brown dolomite. Casing was underreamed to the top of the Silurian and cemented. Returned to production, the well produced 70 bbl. of oil daily and 300 bbl. of water.

Meanwhile, Phillips Petroleum Company of Bartlesville, Okla. completed a reflection seismograph survey of the area lying north of the discovery; in December, Indian Territory Illuminating Oil Company assigned a seismograph crew to the same area for a detailed survey.

The next wildcat test in the region was spudded on November 21, two miles southwest of the pool discovery. Location stakes were driven at No. 1 Mrs. Mabel Myers, in the center northwest, northwest of section 24-1N-15E. Silurian lime was found structurally, low and yielded only salt water.

Carter Oil Company (production subsidiary of the Standard Oil Company of New Jersey) drilled a slim-hole rotary test in southern Brown county, Kansas, 25 miles due south of the discovery well, following an anticline whose major axis courses from north to south. Results remain confidential.

The Apache Exploration Company, affiliate of the Pawnee Royalty Company which mapped the discovery structure, has prepared a seismic survey of an acreage block in Marshall and Washington counties, Kansas, on the the west flank of the Nemaha granite ridge to the west of the Falls City discovery. The prospect, however, remains undrilled.

TOPOGRAPHY

The new field lies northeast of the Nemaha river; all drainage in the area is tributary to this westward flowing stream. The surface elevation of the locality ranges from 900 to 1,150 ft. A mantle of glacial drift and loess obscures the Pennsylvanian and lower Permian formations which outcrop rarely in the immediate area. The glacial drift of the second or Kansan continental ice sheet is composed of gravel, sand and boulders. In the stream of the Nemaha river is found alluvium containing gravels, silts and sands.

STRATIGRAPHY

Below the surface material of unconsolidated rocks of glacial origin and loess, lie the Permian and Pennsylvanian strata; the Pennsylvanian comprises chiefly the Virgil, Missouri and the underlying Des Moines series having a thickness of 2,140 ft.

Lower Permian rocks outcrop west of a north-south line passing through range 16 east, in Richardson county, Nebraska, and the same range number in Brown county, Kansas; however, these represent an outlier, the principal formational outcrops lying west of the Nemaha granite ridge. Principal Pennsylvanian outcrops in the Falls City area, where exposed, occupy the middle and lower Wabaunsee group.

The Pennsylvanian groups represent in descending order the Wabaunsee, Shawnee, Douglas, Pedee, Lansing, Kansas City, Bronson, Bourbon, Marmaton and Cherokee. The Cherokee shale is underlain unconformably by rocks of the Mississippian.

Twenty-five miles southeast of the Falls City area, the Mississippian system is represented by 41 ft. of St. Louis (Maremac series) and is underlain by 40 ft. of Warsaw shale, by 120 ft. of Burlington and Keokuk limestones of the Osage sub-series, and by the Kinderhook group comprising 220 ft. of dolomitic limestone, chert, gray limestone, blue-grayish to greenish shale and bluish-gray shale.

Immediately underlying the Mississippian Kinderhook group are dolomite beds of Silurian age which have been correlated with the Lockport group of the Niagaran series in the Appalachian geosyncline province; at Forest City, it is a bluish-gray, crystalline to shaly dolomite with penetration exceeding 134 ft.[1]; the total Silurian formation in the W. F. Davis well at Forest City in Holt county, Missouri, attains a maximum recorded thickness of 459 ft., one of the greatest recorded thickness in the Forest City basin proper.

The Ordovician system underlying the Siluro-Devonian formation is represented by the Maquoketa shale of Richmond age, the Galena-Platteville limestone and the St. Peter sandstone. The greatest recorded thickness of Maquoketa shale in eastern Kansas is 78 feet. in section 8-12S-14E in Shawnee county; it is gray to greenish-gray and is very soft[2]. The next member is the Galena-Platteville limestone with an average thickness of 110 ft., which in turn is underlain by the St. Peter sandstone with a thickness of 65 ft. in this area.

The Cambro-Ordovician system reaches a maximum thickness of 430 ft. of section 14-11S-16E in Shawnee county, Kansas; it is composed of crystalline dolomite, alternating with white-buff and gray-buff with alternating greenish-shale.

A coarse, arkosic sand, "the basal" sand, has been encountered in the Cambrian, ranging from eight to 35 ft. in thickness[3]. Pre-Cambrian rocks immediately underlie the basal sand. Approximately 2,000 ft. of pre-Cambrian schists were encountered at the Beattie well in Marshall county, Kansas; other pre-Cambrian rocks reported include granite or gneiss, quartz porphyry and quartzite.

OUTCROPS

The nearest outcrop of the Silurian system lies 235 miles due eastward of the Richardson county discovery well and is found in eastern Missouri on the northeastern flanks of the Lincoln anticline in the counties of Pike, Lincoln and Ralls; it crosses into Greene, Jersey and Calhoun counties, Illinois.

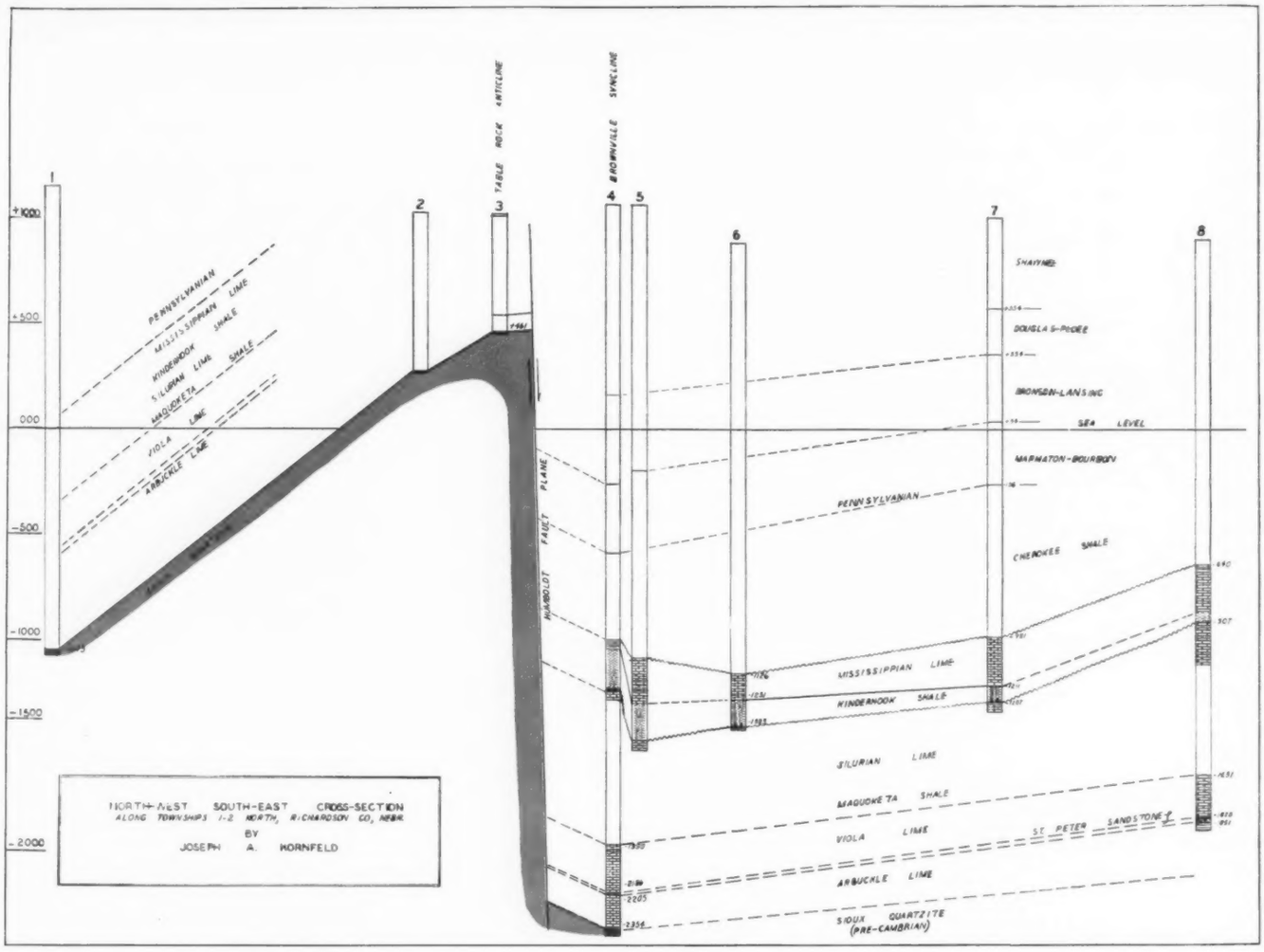
More than 275 miles southeast of the Richardson county oil well, middle Silurian rocks outcrop on the east flank of the Ozark dome in Perry and Cape Girardeau counties, Missouri.

PRODUCTION

Nearest Silurian production lies 170 miles to the southwest in the Graber pool of McPherson county, Kansas. Here accumulation is due to "pinching-out" of the Hunton formation on the southwest flank of the Graber structure; likewise it is productive in the Voshell and Hollow-Nickel pools of McPherson counties under similar conditions incident to sharp, westward-plunging structures.

Two hundred and fifty miles east of the Falls City pool, Silurian production was discovered more than a quarter century ago in the Colmar field of McDonough county on

[1] John W. Ockerman, Subsurface Studies in Northeastern Kansas. State Geological Survey of Kansas, Bull. of the Univ. of Kansas, No. 20, Vol. 36, No. 9, May 1, 1935, page 31.
[2] John W. Ockerman, Op. Cit. page 33.
[3] John W. Ockerman, Op. Cit. page 38.



Northwest-Southeast regional cross section traversing the Table Rock anticline (Nemaha granite ridge) in southeastern Nebraska; this is cross-section A-A' indicated on the regional base map. The discovery oil well is well No. 6 in the section being Pawnee Royalty Company's No. 1 R. E. Boice, C NE NE/4 Sec. 18, Twp. 1 N., Rge., 16 E., in Richardson county. The red imprint illustrates position of the Sioux quartzite of pre-Cambrian age, the "basement-rock" in this region.

the western limb of the Eastern Interior Coal basin in western Illinois. Here well-rounded quartzitic sand is found beneath the Silurian dolomite and overlying the Maquoketa shale of upper Ordovician age. Accumulation is due in part to stratigraphic trap and in part to occurrence of terrace structure on the north side of the Colmar anticline. The pool was discovered in April, 1914 on the J. Hoing farm in sand topped at a depth of 415 ft. and penetrated 100 ft. The initial output was 40 bbl. daily for the first well.

The sole producing horizon encountered at the date of this writing in the Fall City pool is the Silurian limestone; however, a showing of free oil from the Viola lime was claimed for the Arab Petroleum Company's No. 1 Ogle, in Richardson County, 10 miles to the west.

SUBSURFACE

Local structure in the Falls City field is related to a secondary fold lying east of and parallel to the Table Rock anticline, which may be locally faulted by a series of en-echelon faults intersecting the north-south course of its axis. As yet, there is limited proof of this opinion, due to the lack of sufficient subsurface control, the heavy man-

Index in Wells in Cross Section

No.	Operator	Fee		Description	County	Total Depth	Elevation	Finaled In
				NEBRASKA				
1				20-9N-7E	LANCASTER	2463	1,150	PRE-CAMBRIAN QUARTZITE
2		N. F. Clark		12-2N-11E	PAWNEE	765	1,025	PRE-CAMBRIAN
3				25-1N-12E	PAWNEE	565	1,019	PRE-CAMBRIAN PINK GRANITE
4	Arab Petroleum	Ogle	SE SE	9-1N-14E	RICHARDSON	3,423	1,069	PRE-CAMBRIAN
5	E. L. Morgan	Salem	SE NE	26-1N-14E	RICHARDSON	2,540	1,070	
6	Pawnee Royalty	Boice	NWC NW	18-1N-16E	RICHARDSON	2,294	903	SILURO-DEVONIAN
				KANSAS				
7	Valley Petroleum	Mann	SE NW	21-1S-19E	DONIPHAN	2,315	994	SILURO-DEVONIAN
				MISSOURI				
8	E. F. Neely	Shores	SE SE	12-60-37W	ANDREW	2,780	893	ARBUCKLE

CRUDE OIL EVALUATION
FALLS CITY OIL DISCOVERY
Silurian Formation

Sample source—Pawnee Royalty Company's No. 1 R. E. Boice, C NE NE Section 18, Township 1 north, Range 16 east, Richardson County, Nebraska.
Total depth—2,294 feet., November, 1939.
Analyzed by Searle Petroleum Company, Omaha, Nebr. Furnished through courtesy of Mr. H. A. Searle, Jr.

Base	Asphaltic
Gravity	31.4 deg.
Basic Sediment	.39 percent
Water content	0.01 percent
Color	black
Odor	good (little H_2S)
Sulphur content	0.47 percent
Cold test	4 deg. above Zero.

tle of glacial cover obscuring the Pennsylvanian and Permian outcrops, as well as the draping effect of the lower Pennsylvanian rocks over the post-Mississippian land surface, which would diminish any pre-Pennsylvanian faults and/or local truncated structures.

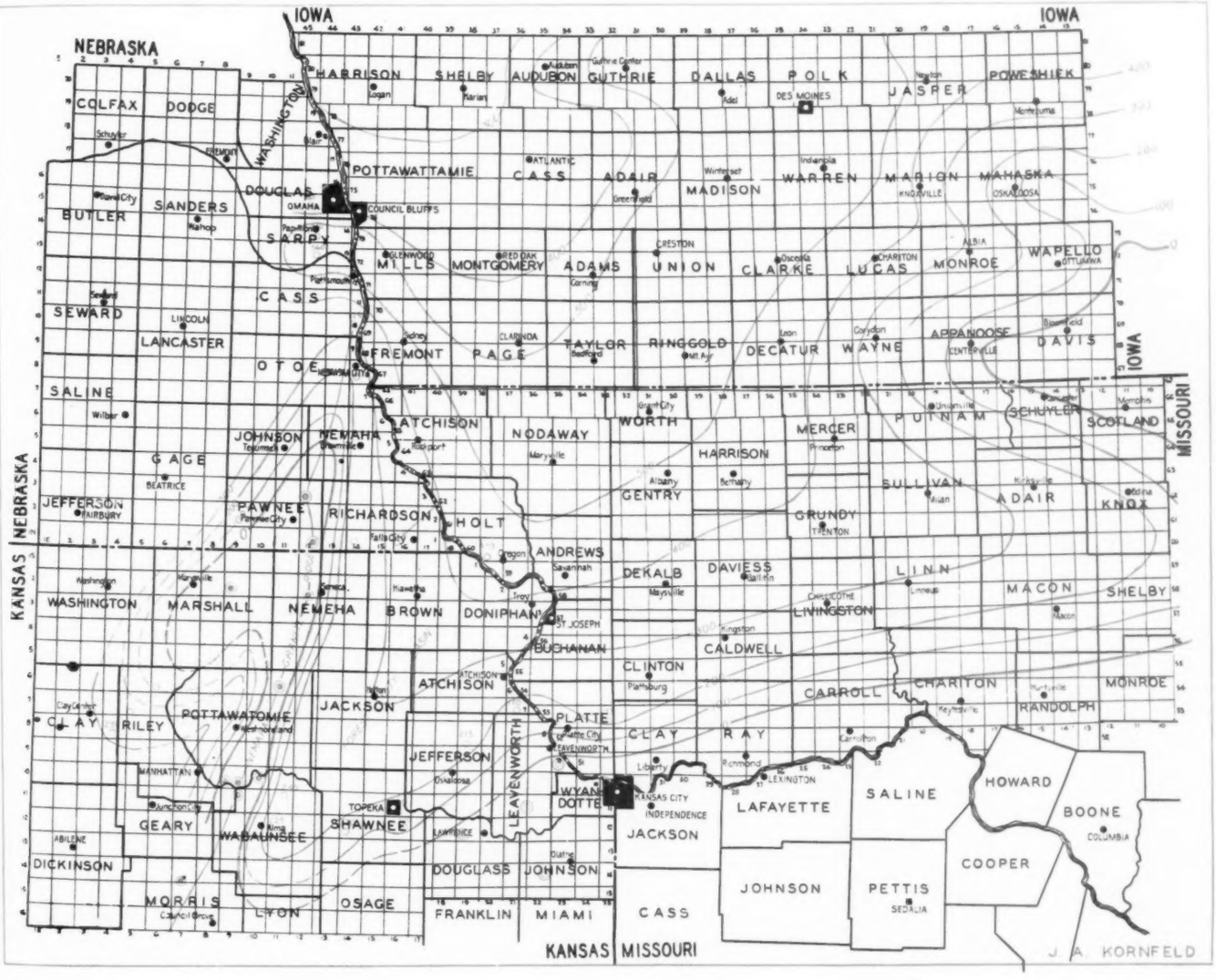
The predominating regional structure is the Nemaha granite ridge and the Table Rock anticline which represents its most northward extension. A series of short en-echelon faults are thought to feature the sharp-dipping east flank of the Nemaha ridge. Fath[4] in explaining this geologic condition believes that "a regional series of essentially parallel master faults or shear zones must have been present in the basement complex; but it must not be concluded that the displacement along any such fault would be of equal magnitude throughout its extent, or in other words that the result of such a displacement is a single, continuous and uniform anticline in the surface rocks; the displacements are probably more or less local in extent."

A displacement or steep dip of 2,800 ft. within a horizontal distance of only 10 miles (from east to west) is indicated by a test drilled near the crest of the Table Rock anticline on the Church farm in section 25-1N-12E, Pawnee county, which topped pre-Cambrian at 461 plus datum (sea level reference) as compared with Arab Petroleum Company's No. 1 Ogle, in the southeast corner of section 9-1N-14E, which encountered the pre-Cambrian at a subsea elevation of 2,351 ft. The Brownville syncline lying east of and parallel to the Nemaha granite ridge strikes north-northeast through eastern Nemaha county into western Richardson county and terminates at Nebraska City in township 8N, range 14E in eastern Otoe county, Nebraska.

The Table Rock anticline is the outstanding local structural feature of the area. It is characterized by a sharp westward dip, although interrupted locally by a broad terrace near its crest in Nemaha county, Kansas, and in Pawnee county, Nebraska. Mapped on top of the pre-Cambrian rocks, it forms a buried, truncated structure, featured by en-echelon faulting on its east flank. In the post-Mississippian pre-Pennsylvanian period of widespread erosion, the structure was uplifted and then truncated by erosion so that the drill encounters successively younger rocks as the outward rim of the anticline is reached; on the pre-Mississippian map of the area, the Cambrian to Silurian strata follow thin contact lines around the periphery of the anticline. More than 450 ft. of closure features the pre-Cambrian surface. The ridge is flanked and overlain by Pennsylvanian strata (the lowest of which comprise the Des Moines series) slumping over the old pre-Pennsylvanian topography especially where the old en-echelon vertical faults occurred.

[4] A. E. Fath, The Origin of the Faults, Anticlines and Buried "Granite Ridge" of the Northern Part of the Mid-Continent Oil and Gas Field. Prof. Paper 128, U. S. G. S. Shorter Contributions to General Geology, 1920, p. 81.

The regional geologic map above shows isopach contours of the Siluro-Devonian system in the Forest City basin. The Siluro-Devonian is the producing section in the first commercial oil well in Nebraska at Pawnee Royalty Company's No. 1 R. E. Boice, Richardson county (shown by arrow) which topped that formation at 2,288 feet. (In part after L. E. Workman).



Oil Industry Faces Uncertain FINANCIAL OUTLOOK

By Henry E. Rose

Increase of Motor Fuel Stocks in Storage Forecasts Record Accumulation by March and Contains Chief Threat to Prices — Little Rise in Export Demand Anticipated — 1939 Earnings Improved in Final Quarter.

AN eventful year lies ahead for the American petroleum industry. That is about the only prediction one can make in the present uncertainty. Many imponderables enter into the situation and it is difficult to forecast, with any degree of reasonableness, their effect on operating conditions. These are aside from internal factors.

The European war, as an instance, has disturbed normal export markets for American petroleum products, and poses an important problem. Moreover, the legislative trend in the United States in respect of the industry; namely, the drive for federal control and divorcement of certain divisions, is a factor which must be reckoned with in looking ahead.

Statistically, the industry, with one exception, is in a sound position. Crude production for the country as a whole is being maintained in fair balance with demand in spite of the lack of regulation in some states. Gasoline inventories, however, are building too rapidly and threaten again, as in 1939, a topheavy position for this primary product by the end of next March when the 1940 period of heavy motor fuel consumption begins. The possible effect of these excessive stocks on prices and profits is obvious.

Gasoline stores at the end of 1939, approximated 80,000,000 bbl. which is within 3,000,000 of what they should be three months hence to constitute a desirable economic level. A year ago on December 31, 1938, they totaled 71,680,000 bbl., then an abnormal figure which, with continued additions, was chiefly responsible for unfavorable earnings in the first six months of 1939 because of the inability of refiners to obtain a satisfactory price for gasoline.

The realization that supplies of this major product are accumulating too rapidly has been reflected recently in softer prices in the important mid-continent and gulf coastal areas. The tank wagon quotation in fifty leading cities, for example, averages fractionally lower than a year ago, while the wholesale price average in important markets has tended downward also. The latter, however, is still approximately half a cent a gallon higher than a year ago, although there was a wider spread several months ago.

The seriousness of the gasoline situation cannot be over-emphasized. If only the same amount is added to inventories during the next three months as in the similar period of 1939; namely, 15,400,000 bbl., the total would be elevated to a new peak of around 95,000,000 bbl., or approximately 12,000,000 in excess of a desirable position. That they may exceed 95,000,000 bbl. is a probability. Currently the industry is producing 10 percent more gasoline than a year ago against an estimated increment in demand of about five percent.

Moreover, the industry's tank storage capacity for gasoline is estimated around 100,000,000 bbl. so that an approach to that figure would bring distress selling by some refiners and cause pressure on prices.

A factor bearing on the gasoline position is the substantially increased demand for fuel oils, light and heavy, in face of smaller stocks in the important eastern gulf coastal, and interior, areas; and is necessitating a high level of refinery operations. This heavier demand arises from the larger number of home heating appliances in use and from an expansion of industrial operations in recent months.

The severity of weather conditions in the next three months will determine whether gasoline stocks top the estimated 95,000,000 bbl. level. If the winter is a normal one (the last two have been warmer than normal) the demand for home heating oil will be increased while motor fuel consumption will decline, thus expanding inventories of the latter accordingly.

Forecasts of the industry's leading economists as to possible 1940 gasoline consumption do not lend encouragement to the outlook from a price viewpoint in face of ascending stocks. It appears, from these forecasts, that the American industry is not likely to share heavily as a supplier to belligerent nations even though gasoline is essential for the successful prosecution of mechanized war. The normal foreign demand, moreover, has been affected by inability to obtain transport facilities.

Since the beginning of European hostilities on September 1, last, exports of gasoline have been below normal. While September shipments were moderately higher than in September, 1938, the October and November export movements were sharply lower than in the corresponding months a year ago. For all of 1939 exports probably will approximate 48,000,000 bbl., or about four percent smaller than in 1938. The export demand for 1940 is placed at approximately the total of 1938, or slightly more than 50,000,000 bbl., which would mean an increase of only 2,000,000 bbl. over last year. Domestic demand this year, giving effect to new motor cars in use, is expected to approximate 575,000,000 bbl., or 4.5 percent larger than in 1939.

While crude oil production for the country, as a whole, has been in fair balance with the demand, this has been accomplished by restricting output in such states as Texas, Oklahoma, Kansas and Michigan under conservation measures. Illinois still has no such control, although it is possible that a measure will be enacted this year.

To a large extent, the rapid development of Illinois fields, with consequent increased production, was responsible for the weakness in the mid-continent crude price structure last August. At that time approximately one-third of the Illinois output was moving at a discount under posted prices and considerable quantities of crude were available in other southwestern states similarly, thus impairing the mid-continent price base. The swift, unprecedented action of regulatory bodies in six southwestern states—Texas, Louisiana, Oklahoma, New Mexico, Kansas and Arkansas—ordering the shutting down of all wells for fifteen days, averted a collapse in prices. The shutdowns also resulted in the withdrawal of some 30,000,000 bbl. of crude oil from storage, and the crude position was strengthened to that extent.

California, which has been operating under voluntary curtailment among producers, attempted to enact a control measure last year but it was defeated at the polls in November. Reports emanating from there indicate that an effort might be made to gain some degree of regulation by an amendment to the state's gas act. Meanwhile the system of voluntary regulation operated by the producers themselves continues to work with fair success in curtailing output. So long as voluntary restriction serves to meet the situation it is unlikely that pressure will be brought to enact legislation.

Furthermore, California is far removed from the important mid-continent producing area and price changes in the former are not necessarily reflected in the latter. Any effect would be purely psychological unless California prices drifted so low as to make it possible to compete with mid-continent crude.

These situations of unrestricted production, especially in Illinois, are being cited by those who are agitating for federal control of the oil industry. The drive to bring the industry under the direct authority of the national government is not likely to be dropped so long as its leaders retain high office. Congress may take action on this subject at the present session although sentiment appears against enactment of the Cole bill in the form in which it was introduced.

Profitwise, the American oil industry's results in 1939 almost paralleled those of 1938 although, for the most part, earnings were made in the final six months. The first three

months were the poorest, earnings in that period, in the aggregate, being down more than 60 percent compared with the similar quarter of 1938. The carrying over of lower prices from the final months of 1938 for both crude oil and gasoline was chiefly responsible for the unfavorable showing.

For the second three months, when a moderate improvement in wholesale prices developed in June, the profit level turned upward somewhat. The third quarter reflected added improvement in line with further price firming, and in spite of the fifteen-day shutdown of oil wells in six southwestern states. The latter had an adverse effect on companies solely engaged in producing and on a few integrated companies heavily interested in the natural gasoline business.

While the European war has not brought an extraordinary demand on American companies for products, other than lubricating oils and wax, its outbreak led to a slight upturn in prices for refined products. Recently, however, because of the paucity of foreign demand and accumulating stocks of gasoline, prices for that product have been receding.

The effect of moderately improved prices, especially for gasoline, lubricating and fuel oils, was reflected in earnings for the final quarter. While these are not yet reported, they were the best for the year, and well ahead of the similar period in 1938 when, because of lower prices for both crude oil and gasoline, a number of companies were compelled to write down inventory values. The adjustments, for several companies, reduced profits for all of 1938 below the first nine months of that year.

Since the improvement last year was largely applicable to refined products, the fully integrated companies were the chief beneficiaries. From early indications, it is probable that a dozen major companies finished the year with net income exceeding that for 1938. Among these may be listed Standard Oil Co. (N. J.); Continental Oil Co.; Standard Oil Co. of Indiana; Standard Oil Co. of Ohio; Phillips Petroleum Co.; Pure Oil Co.; Mid-Continent Petroleum Corp.; Texas Corp., and South Penn Oil Co.

Integrated companies which are likely to approximate their 1938 income included Socony-Vacuum Oil Co., Inc.; Gulf Oil Corp.; Creole Petroleum Corp.; Consolidated Oil Co., Shell Union Oil Corp., and Atlantic Refining Co. Since several of these operate in foreign fields, it is possible, depending on the setting aside of contingency and other reserves, that one or more may be added to the group showing larger profits than in 1938.

Principal California integrated companies, such as Standard Oil Co. of California and Union Oil Co., will report smaller profits in reflection of lower average prices for refined products and curtailment of crude production. An exception will be Richfield Oil Corp. which, because of completion of a large refinery late in 1938, the acquisition of a new source of crude oil and expanded sales outlets, will show an improvement in last year's earnings.

Solely producing companies, which received no higher price for their product in the mid-continent during the year, also completed 1939 with smaller profits than in the previous year. These include Amerada Corp.; Barnsdall Oil Co.; Seaboard Oil Co.; Plymouth Oil Co. and Texas Gulf Producing Co. For the first nine months of 1939 their profits ranged from 14 percent to 51 percent smaller than in the corresponding period of 1938. Seaboard and Plymouth made the best showings, the reductions in their profits to September 30, last, being only 14 percent and 16 percent, respectively.

For 28 companies issuing interim reports for the first nine months, profits aggregated $75,606,274 against $107,606,264 in the corresponding period of 1938, a diminution of 30 percent. During the first six months of 1939 the reduction amounted to 37 percent.

Cash dividend payments on common stocks of 24 leading companies in 1939 were less than five percent below those in the preceding year, totaling $194,391,679 against $204,845,245. The largest cash disbursement was by Standard Oil Co. (N. J.) of $33,272,580, equal to $1.25 a share, against $39,927,096, equal to $1.50 a share, in 1938. Last year the company distributed, in addition to the cash payment, a common stock dividend equal to 2½ percent against 1½ percent in 1938.

Several companies paid larger cash dividends in 1939 than in the preceding year. Standard Oil Co. of Indiana paid out the equivalent of $1.25 on common against only $1 in 1938; Standard Oil Co. of Ohio disbursed $1.50 against $1. On the other hand, Shell Union Oil Corp. cut its payment to 50 cents from 70 cents in 1938; Skelly Oil Co., to 75 cents from $1; Standard Oil Co. of California to $1.10 from $1.40; Union Oil Co. of California to $1.05 from $1.20 and Tide Water Associated Oil Co. to 80 cents from $1.

Ohio Oil Co. made no distribution on common stock during 1939 whereas it paid 20 cents a share in 1938. Pure Oil Co. paid out 25 cents a share last year against nothing in 1938.

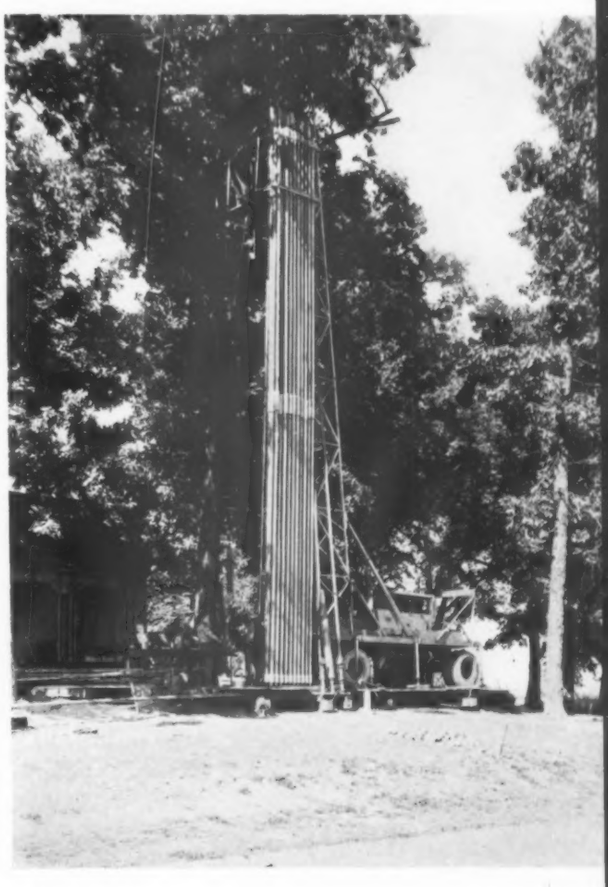
In the accompanying tabulation is shown net income of a group of representative companies reporting quarterly for the first three periods in 1939 with comparisons for corresponding periods in 1938:

Net Income For Representative Companies

	1939 Net Inc.	1939 A Share	1938 Net. Inc.	1938 A Share
Amerada Corp.				
1st Quarter	$319,761	$ .41	$434,889	$ .55
2nd Quarter	355,228	.45	448,172	.57
3rd Quarter	108,636	.14	473,825	.60
Nine Months	783,625	.99	1,356,886	1.72
Atlantic Refining Co.				
1st Quarter	537,280	.15	2,046,897	.71
2nd Quarter	812,629	.25	816,614	.25
3rd Quarter	1,774,539	.61	1,066,896	.34
Nine Months	3,124,448	1.01	3,930,407	1.31
Barnsdall Oil Co.				
1st Quarter	565,417	.25	923,797	.41
2nd Quarter	492,622	.22	766,242	.34
3rd Quarter	204,427	.09	912,290	.40
Nine Months	1,262,466	.56	2,602,329	1.15
Continental Oil Co.				
1st Quarter	721,424	.15	1,805,197	.38
2nd Quarter	1,815,856	.39	1,281,511	.27
3rd Quarter	1,528,562	.33	2,706,698	.57
Nine Months	4,065,842	.87	5,793,406	1.23
Mid-Continent Petroleum Corp.				
1st Quarter	(d) 37,957(d)	.02	468,311	.25
2nd Quarter	678,793	.36	574,264	.31
3rd Quarter	478,497	.26	465,042	.25
Nine Months	1,119,333	.60	1,507,617	.81
Ohio Oil Co.				
1st Quarter	(d) 297,552(d)	.13	1,292,148	.07
2nd Quarter	154,993	(*)	1,391,368	.09
3rd Quarter	262,971	(*)	1,252,346	.07
Nine Months	120,412	(*)	3,935,862	.23
Phillips Petroleum Co.				
1st Quarter	1,485,553	.33	2,314,642	.52
2nd Quarter	2,288,536	.52	3,270,497	.74
3rd Quarter	1,704,988	.38	3,886,816	.87
Nine Months	5,479,057	1.23	9,471,956	2.13
Plymouth Oil Co.				
1st Quarter	619,762	.62	702,892	.69
2nd Quarter	552,942	.54	625,228	.61
3rd Quarter	500,662	.49	665,886	.66
Nine Months	1,673,366	1.64	1,994,006	1.97
Seaboard Oil Co.				
1st Quarter	401,051	.32	456,729	.37
2nd Quarter	384,380	.31	437,157	.35
3rd Quarter	384,157	.31	466,162	.37
Nine Months	1,169,588	.94	1,360,308	1.09
Shell Union Oil Corp.				
1st Quarter	478,266	(*)	2,907,447	.19
2nd Quarter	1,684,156	.09	2,922,990	.19
3rd Quarter	4,548,236	.31	3,534,056	.23
Nine Months	6,710,658	.40	9,364,493	.61
Skelly Oil Co.				
1st Quarter	239,080	.14	664,771	.56
2nd Quarter	517,838	.42	613,471	.51
3rd Quarter	609,327	.52	695,180	.62
Nine Months	1,366,245	1.08	1,973,422	1.69
Standard Oil Co. of California				
1st Quarter	3,226,017	.25	7,130,486	.55
2nd Quarter	3,891,587	.30	8,282,949	.64
3rd Quarter	5,523,295	.42	8,480,446	.65
Nine Months	12,640,899	.97	23,893,880	1.84
Tide Water Associated Oil Co.				
1st Quarter	1,234,182	.11	3,250,264	.42
2nd Quarter	1,097,228	.08	2,742,441	.34
3rd Quarter	2,048,908	.23	2,424,200	.29
Nine Months	4,380,318	.42	8,416,905	1.05
Union Oil Co. of Cal.				
1st Quarter	1,054,635	.23	2,300,000	.49
2nd Quarter	1,596,509	.34	2,650,000	.57
3rd Quarter	1,898,569	.41	1,450,000	.31
Nine Months	4,549,713	.98	6,400,000	1.37

(d) Deficit.
(*) Earnings on preferred stock only.

Portable Diesel Caterpillar rig in Illinois where unrestricted production has been a constant threat to crude prices.



TIDE WATER Finds Operating Committee System Efficient

Divisional Groups Handle Routine Operations and Through Their Chairmen Report Directly to the Company's President Who Formulates Major Policies With Aid of General Coordinating Committee.

© Blackstone

William F. Humphrey, president, Tide Water Associated Oil Company.

ON THE first of November William F. Humphrey, president of Tide Water Associated Oil Company, announced that Edward L. Shea had tendered his resignation as executive vice president of that company to become president of The North American Company. Mr. Humphrey stated that the board of directors of Tide Water Associated Oil Company, after accepting Mr. Shea's resignation, discontinued the office of executive vice president. It was explained there will be no change in the company's policies or methods of operation. The operations of the three divisions of the company, Tide Water Eastern Division, Tide Water Mid-Continent Division and Associated Division, will continue, as in the past, to be conducted under the supervision of existing operating committees in each of the divisions, with the chairmen of these committees responsible directly to the president for the operations of their respective divisions.

Tide Water Associated Oil Company was organized in 1926 as a holding company, owning a substantial majority of the outstanding shares of the common capital stock of Tide Water Oil Company, organized in 1888 and operating in the eastern and mid-continent sections of the country, and Associated Oil Company, organized in 1901 and operating in the Pacific Coast states. In November, 1936, Tide Water Oil Company and Associated Oil Company were merged with and into Tide Water Associated Oil Company and the latter became an operating company. The merged company was divided into three divisions, the Tide Water Eastern Division operating in the east, the Tide Water Mid-Continent Division operating in the mid-continent section of the country, and the Associated Division operating on the Pacific Coast. Because of the geographic locations of its major operations and the widespread activities of the merged company, it was deemed advisable to appoint operating committees to conduct the company's normal routine operations in the respective divisions. These operating committees will continue to function as heretofore, except that their respective chairmen will report directly to the president.

It might be interesting to know more about this committee form of supervision which has been found to be highly efficient and most successful in operating a company with such widespread activities. The three operating committees are headquartered in New York, San Francisco and Tulsa. The members of the committees are the vice presidents and executives responsible for the activities of the respective branches of the business delegated to their supervision. The committees have jurisdiction over the normal routine operating activities of their respective divisions and are authorized to act within prescribed limits and within the operating and financial budgets previously approved by the president and the board of directors.

The chairman and vice chairman of each of the three operating committees, together with the president, constitute the "General Coordinating Committee". This committee is to assist the president in formulating major policies and programs governing the over-all operations of this company and is authorized to exercise, through the president, any and all powers necessary to coordinate and control the activities of the company.

This committee form of administration, which several other large corporations have also found desirable, lends itself to a more cooperative performance and a better coordination of activities than would be attainable otherwise with operations so widespread geographically. The round-table discussion of problems of major importance by the executives of all branches of the business affords an over-all viewpoint of the effect on the company's activities as a whole before a decision is made to proceed in the activities of any one branch of the business. It also makes for well-rounded operating executives in the highly technical, complex and competitive petroleum industry, with a knowledge of the operations of each division and of the company as a whole.

Each of the principal executives of Tide Water Associated Oil Company has had wide experience in the operating branches of the oil business and has a long service record with the company and its former subsidiaries.

William F. Humphrey has been directly connected with the organization for 14 years. He was elected president of Associated Oil Company in 1926 and served in that capacity until 1936 when the company was merged with Tide Water Associated Oil Company. He also served as chairman of the board of directors of the former Tide Water Oil Company and has been president of Tide Water Associated Oil Company since 1933. During this long period of service, Mr. Humphrey has administered the major operating policies and programs, as well as financial policies, of the various companies of which he was the chief executive, and has a thorough knowledge of the operating branches of the business.

In the Tide Water Eastern Division, C. R. Barton, vice president in charge of manufacturing, and J. D. Collins, vice president in charge of domestic sales, have each been with the company for 19 years. K. R. Hankinson, vice president and treasurer, has been with the company 18 years; G. J. Hanks, vice president in charge of transportation, 25 years; Noel Robinson, vice president and director, 23 years, and R. E. Ryerson, vice president in charge of wholesale, export and industrial sales, 13 years.

In the Mid-Continent division, Ralph B. Pringle, vice president and director, has been with the company 10 years, and E. H. Salrin, vice president in charge of production and director, has been with the company 25 years.

In the Associated Division, L. F. Bayer, vice president in charge of manufacturing and director, has been with the company 23 years. L. C. Decius, vice president in charge of production, 24 years; B. I. Graves, vice president in charge of sales and director, 30 years, and L. D. Jurs, vice president in charge of transportation and director, 28 years.

President Humphrey is very proud of his operators and finds that their years of experience, combined with their knowledge of the industry, has resulted in the economical and successful conduct of the company's operations, and with the group continuing under this same mode of operating promises success for the future.

Foreign Oil Legion

HENRY LATHAM DOHERTY, president of Cities Service Company, died on the 26th of December at the age of 69. His death occurred at Temple University Hospital in Philadelphia as a result of bronchial pneumonia.

Mr. Doherty was born in Columbus, Ohio, May 15, 1870 of English, Scot and Irish ancestry and after a very brief period of formal education, went to work for Columbus Gas Co. By 1896 he had become chief engineer despite his lack of formal engineering training. From this position his interests expanded, he became manager of a number of public utilities and early in this century organized Henry L. Doherty and Co., which within a few years became the holding company for Cities Service Company. Mr. Doherty was president of Cities Service for thirty years until the time of his death.

Mr. Doherty will long be remembered as one of the first, not only to recognize the importance of pressure maintenance in oil pools, but to propose and to fight for a practical plan by which this objective might be obtained. Long before the majority of the industry recognized its importance, the president of Cities Service was advocating unit operation of all oilfields.

This principal has since been recognized throughout the industry, state proration laws are based on the avoidance of waste through reservoir pressure maintenance and unit operation is required by law on all public lands. In 1938 the American Institute of Mining and Metallurgical Engineers awarded the Anthony F. Lucas medal to Mr. Doherty in recognition of his early work in advocating scientific production of oilfields from the standpoint of energy conservation.

Mr. Doherty will be succeeded in his position as president of Cities Service by W. ALTON JONES, first vice-president since 1927. Mr. Jones became a director of Cities Service in 1922 and chairman of the executive committee of Henry L. Doherty and Company in 1925. He is a member of the Lotos Club, Lawyers Club, and Metropolitan Club, director of the American Petroleum Institute and chairman of the Richfield Oil Company finance committee.

W. Alton Jones

Bart W. Gillespie

N. M. Lawrence, Pasadena, California, petroleum engineer with the Italian company in Albania, snapped by the ship's photographer when he sailed from New York, December 14, on the S. S. REX to return to his headquarters in Rome. Mr. Lawrence has a long period of foreign service to his credit and has directed work in Poland and Formosa as well as Albania.

BART W. GILLESPIE who has for a number of years been active in the petroleum operations of the Latin American countries has joined the organization of Security Engineering Co., Inc., Whittier, California, as export manager.

Mr. Gillespie returned recently from a year with the Y. P. F.—the Argentine Government's petroleum producing unit. He spent the two years prior to that with the Ganzo Azul of Peru and earlier was associated with the A. G. W. I. of Mexico.

(Continued on page 48)

Left to right, J. C. Coe, H. C. Snyder and D. O. Rhoten of the drilling department, H. E. Weeden, petroleum engineer, and L. G. Harder, drilling department en route for Arabia from New York this fall.

WORLD OIP

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specif Figures

U. S. BARRELS

	Dec. 1938	Jan. 1939	Feb. 1939	Mar. 1939	Apr. 1939	May 1939	June 1939	July 1939	Aug. 1939	Sept. 1939	Oct. 1939	Preliminary Figures Nov. 1939
United States	102,287,000	102,490,000	93,475,000	106,768,000	105,510,000	110,541,000	104,607,000	110,937,000	80,865,000	108,168,000	114,197,800	102,390,660
Soviet Union[4]	17,050,000	17,000,000	17,500,000	18,000,000	18,100,000	18,500,000	18,700,000	18,200,000	18,100,000	18,000,000	18,406,932[1]	17,813,160
Venezuela	16,744,163	16,489,347	14,899,459	15,646,415	16,980,646	17,676,580	16,430,625	18,015,249	18,743,714	18,652,354[1]	17,434,307	16,871,910
Iran[5]	6,624,726	6,402,924	4,978,350	6,992,667	7,237,755	6,801,192	6,341,652	6,637,503[1]	6,637,503[1]	6,423,390[1]	6,637,503[1]	6,423,390
Netherland India: Sumatra	3,177,589	3,129,007	3,113,863	3,393,286	3,401,503	3,602,543	3,498,094	3,557,020	3,550,123	3,502,437	3,600,371	3,389,610
Borneo	1,114,535	1,115,570	1,049,439	1,144,647	1,113,474	1,173,509	1,154,341	1,156,942	1,111,810	865,693	995,207	1,070,760
Java[5]	529,658	535,297	527,836	550,097	509,355	530,273	514,565	565,181	559,096	511,355	556,658	528,900
Ceram	45,773	49,200	57,896	67,440	82,914	89,975	77,305	73,962	71,767	68,065	64,292	69,330
Roumania	3,969,300	3,953,671	3,665,559	3,973,053	3,743,881	3,840,413	3,684,366	3,902,208	3,945,625	3,795,308	3,842,567	3,784,200
Mexico[18]	3,245,558	2,470,000	1,960,000	3,118,021	3,140,120	2,945,000	3,100,000	3,245,000	3,700,000[1]	4,050,000	3,148,608	3,047,040
Iraq	2,290,777	2,422,325	1,961,152	2,699,272	2,608,235	2,663,827	2,721,992	2,807,402	2,615,129[1]	2,530,770	2,615,129	2,530,770
Colombia	1,908,879	1,710,565	1,633,621	1,818,765	1,826,928	1,899,735	1,851,716	1,798,271	1,950,966	1,894,941	1,860,620	1,800,660
Trinidad	1,664,322	1,652,412	1,499,197	1,630,789	1,569,298	1,645,040	1,575,321	1,620,564	1,636,645[1]	1,583,850[1]	1,636,645[1]	1,583,850
Argentina[1]	2,028,000	1,534,000	1,430,000	1,556,000	1,549,000	1,556,000	1,530,000	1,556,000	1,556,000	1,559,683	1,569,933	1,519,290
Peru[4]	1,321,883	1,251,162	1,103,878	1,210,288	1,151,193	1,078,426	1,051,265	1,100,000[1]	1,100,000[1]	1,116,810[1]	1,154,037[1]	1,116,810
Bahrein[6]	623,907	647,988	610,766	658,822	629,336	626,009	628,812	671,892	698,714	647,595	660,858	639,540
Burma[7]	651,495	600,863	424,277	698,103	581,633	696,936	665 942	628,153[1]	628,153[1]	607,890[1]	628,060	607,890
Canada[8]	489,303	535,166	358,176	385,273	559,368	713,947	821,308	899,169	795,844	720,866	816,257	651,840
Brunei[9]	510,500	497,324	445,383	492,374	466,328	486,815	464,271	490,318	499,520	474,330	490,141	474,330
Great Germany: Old Reich[14]	313,206	332,601	332,965	396,181	373,126	407,028	373,510	391,098	381,114[1]	368,820[1]	381,114[1]	368,820
Ostmark[15]	34,259	33,634	46,701	43,293	54,375	64,840	74,726	85,131	58,869[1]	56,970[1]	58,869[1]	56,970
Slovakia and Moravia	9,879	10,486	9,000[1]	10,000[1]	9,000[1]	10,000[1]	9,000[1]	11,000[1]	11,000[1]	9,810[1]	10,137	9,810
Poland	323,575	325,093	298,259	333,618	326,436[1]	333,800[1]	318,000	330,000[1]	330,000[1]	320,370[1]	331,049	320,370
Japan[10]	222,387	224,903	218,612	222,386	218,612	221,129	221,128	222,072	210,105	222,513	222,701[1]	239,460
British India[11]	217,528	253,730	213,185	236,042	105,477	127,700	137,070	183,830[1]	183,830[1]	177,870[1]	183,799[1]	177,870
Ecuador	192,882	195,556	171,634	181,938	175,896	193,353	193,710	206,868	204,115	193,720	193,382	188,490
Saudi Arabia	139,038	155,605	170,865	215,270	234,742	281,325	302,932	342,558	350,000	538,136	512,590	313,737
Sarawak[12]	118,512	118,932	100,358	115,990	110,982	112,572	104,224	107,961	113,894[1]	110,220[1]	113,894[1]	110,220
Egypt[13]	221,156	308,946	301,102	330,445	328,376	368,081	425,231	436,519	440,678	362,880[1]	374,976	362,880
Italian Empire: Albania[16]	6,220	99,206	67,914	125,440	244,576	81,839	79,931	140,025	89,000[1]	111,276	117,986	114,180
Italy	7,937	7,511	8,090	8,324	7,792	7,253	7,181	6,843	7,600[1]	7,736	7,750	7,500
France	48,000[1]	42,000[1]	40,000[1]	42,000[1]	41,000[1]	42,000[1]	41,000[1]	42,000[1]	42,000[1]	42,653	42,470	41,160
Hungary	47,671	49,199	49,578	67,261	67,000[1]	70,000[1]	67,000[1]	70,000[1]	70,000[1]	65,210	65,317	63,210
Bolivia[1]	9,000	8,800	7,000	8,700	8,500	8,700	8,500	8,700[1]	8,700[1]	7,893	8,556	8,220
Other Countries[17]	48,000	50,000	35,000	50,000	48,000	50,000	48,000	50,700	50,700	50,000	49,073	47,490
WORLD TOTAL	168,236,618	166,703,023	152,772,114	173,160,200	173,114,857	179,401,840	171,829,718	180,497,139	151,317,214	177,819,414	182,989,588	169,744,355

[1] Estimated.
[2] Includes natural gasoline (naphtha) production.
[3] International Petroleum Company and Lobitos Oilfields, Ltd., figures combined.
[4] Russian Saghalin included with U.S.S.R.
[5] Anglo-Iranian Oil Company, Ltd., figures revised —fuel oil returned to the ground has been deducted.
[6] Bahrein Petroleum Company, Ltd., figures.
[7] Does not include Assam or Punjab, which are listed together under British India.
[8] British Malayan Petroleum Company, Ltd., figures.
[9] Includes Madura.

Comparative Cumulative Daily Averages in Barrels

	Jan.-Nov. 1939	1938
United States	3,413,022	3,335,421
Soviet Union	593,772	565,905
Venezuela	562,397	505,372
Iran	214,113	210,042
Netherland India: Sumatra	112,987	93,343
Borneo	35,782	34,742
Java	17,630	19,760
Ceram	2,311	1,703
Roumania	126,140	136,309
Mexico	101,568	92,011
Iraq	84,359	86,486
Colombia	60,020	58,304
Trinidad	52,795	47,523
Argentina	50,643	44,655
Peru	37,227	43,777
Bahrein	21,318	23,632
Burma	20,263	20,703
Canada	21,728	19,474
Brunei	15,811	14,431
Great Germany: Old Reich	12,294	10,614
Ostmark	1,899	963
Slovakia and Moravia	327	354
Poland	10,679	10,470
Japan	7,982	6,933
British India	5,929	6,254
Ecuador	6,283	6,176
Saudi Arabia	10,210	243
Sarawak	3,674	4,275
Egypt	12,096	3,369
Italian Empire: Albania	3,806	1,463
Italy	250	297
France	1,372	1,422
Hungary	2,045	709
Bolivia	276	294
Other Countries	1,580	355
WORLD TOTAL	5,626,794	5,422,853

Official Crude Oil Production Figures for 1932 to 1938 (Revised) in Barrels

	1938	1937	1936	1935	1934	1933	1932
United States	1,213,254,000	1,279,160,000	1,098,516,000	996,596,000	908,065,000	905,656,000	785,159,000
Soviet Union	206,192,000	201,856,661	199,635,921	184,008,033	175,635,783	155,596,429	155,927,997
Venezuela	173,506,497	187,675,477	155,270,840	148,809,057	136,098,681	117,113,940	115,615,782
Iran	78,320,840	78,109,001	62,977,950	57,520,488	57,902,092	54,440,075	49,516,697
Netherland India: Sumatra	34,538,128	33,451,511	30,469,428	28,004,595	26,336,011	22,345,172	18,570,923
Borneo	12,812,383	12,960,072	13,068,910	13,529,185	14,335,543	15,003,175	15,228,615
Java	6,955,283	7,152,931	3,618,293	3,462,440	3,778,920	3,600,816	3,837,142
Ceram	607,622	537,436	375,823	311,872	273,698	285,335	309,957
Roumania	48,366,000	52,395,725	63,532,846	61,270,072	61,849,306	53,919,708	53,651,978
Mexico	38,505,824	46,455,687	41,027,915	40,240,563	38,171,946	34,000,830	32,805,496
Iraq	32,404,000	30,603,660	29,913,150	27,410,983	7,639,849	1,094,915	87,840
Colombia	21,581,588	20,297,543	18,756,110	17,597,655	17,337,900	13,156,126	16,415,214
Trinidad	17,736,176	15,502,989	13,237,030	11,671,224	10,894,363	9,561,353	10,126,121
Argentina	17,076,223	16,354,717	15,457,960	14,297,025	14,021,901	13,690,556	13,138,747
Peru	15,908,279	17,459,112	17,593,069	17,056,555	16,314,381	13,257,318	9,899,265
Bahrein	8,297,998	7,762,264	4,644,635	1,264,807	285,072	31,377	902
Burma	7,499,498	7,847,553	7,587,718	7,181,113	7,278,859	7,114,311	7,073,437
Canada	6,936,479	2,995,025	1,507,931	1,447,204	1,410,895	1,145,333	1,044,413
Brunei	5,387,214	4,397,038	3,296,938	3,302,905	2,705,350	2,035,656	1,200,026
Great Germany: Old Reich	3,850,044	3,148,300	3,076,858	2,967,438	2,204,402	1,656,602	1,594,807
Ostmark	370,038	221,266	50,092	44,347	27,965	5,765	804
Slovakia and Moravia	132,005	123,474	126,603	136,580	177,797	121,695	126,663
Poland	3,828,438	3,799,862	3,869,575	3,901,881	4,011,336	4,174,079	4,219,634
Japan	2,511,184	2,487,841	2,403,072	2,294,878	1,872,837	1,504,412	1,683,439
British India	2,330,209	2,161,653	1,978,329	2,037,810	1,921,863	1,628,803	1,743,878
Ecuador	2,257,278	2,161,436	1,942,467	1,731,785	1,636,619	1,619,902	1,597,641
Saudi Arabia	495,135	64,968	19,777	Nil	Nil	Nil	Nil
Sarawak	1,624,882	1,655,565	1,547,882	1,776,593	1,942,591	2,206,815	2,329,733
Egypt	1,561,231	1,163,267	1,262,666	1,255,151	1,527,252	1,653,535	1,071,976
Italian Empire: Albania	437,597	380,292	219,693	41,218	17,500	11,437	9,212
Italy	106,083	112,700	129,653	128,615	162,449	213,534	242,563
France	516,240	507,067	534,063	529,664	700,000	786,366	755,146
Hungary	330,829	13,910	100	Nil	Nil	Nil	Nil
Bolivia	106,620	123,123	104,746	163,295	157,875	111,973	41,907
Other Countries	243,000	70,000	37,100	32,300	64,000	54,100	73,300
WORLD TOTAL	1,966,586,845	2,041,169,126	1,797,791,150	1,652,023,331	1,516,760,036	1,438,797,443	1,305,100,199

PRODUCTION

Figures in U. S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries

METRIC TONS

	Dec. 1938	Jan. 1939	Feb. 1939	Mar. 1939	Apr. 1939	May 1939	June 1939	July 1939	Aug. 1939	Sept. 1939	Oct. 1939	Preliminary Figures Nov. 1939
United States	13,846,893	13,874,374	12,653,243	14,445,677	14,275,470	14,956,000	14,153,000	15,009,700	10,941,000	14,608,036	15,450,953	13,852,050
Soviet Union[4]	2,339,000	2,332,000	2,400,000	2,469,000	2,480,000	2,536,000	2,590,000	2,500,000	2,480,000	2,300,000	2,508,024[1]	2,457,120
Venezuela	2,474,385	2,438,207	2,201,782	2,323,150	2,521,254	2,624,585	2,439,598	2,674,870	2,783,031	2,769,466	2,586,268	2,502,840
Iran[5]	876,168	849,376	660,400	927,608	960,120	902,208	841,248	880,493[1]	880,493[1]	852,090[1]	880,493[1]	852,090
Netherland India: Sumatra	426,522	420,001	398,651	434,424	435,476	461,214	447,842	455,386	454,503	448,398	460,936	435,870
Borneo	149,602	149,741	134,354	146,543	142,552	150,238	147,784	148,117	142,339	110,830	127,411	138,120
Java[3]	71,095	71,852	67,576	70,426	65,210	67,888	65,877	72,357	71,578	65,466[1]	71,266	68,040
Ceram	6,144	6,604	7,412	8,634	10,615	11,519	9,897	9,469	9,188	8,842	8,231	8,910
Roumania	541,884	536,091	497,025	538,719	507,645	520,734	499,575	529,113	535,000	514,618	521,026	513,090
Mexico[13]	481,823	367,000[1]	287,813	457,859	461,104	432,452	455,212	476,505	543,316[1]	594,713	462,830	447,900
Iraq	312,734	323,797	262,151	360,817	348,648	356,079	363,854	375,271	349,556[1]	338,280	349,556	338,280
Colombia	266,046	238,572	227,841	253,663	254,802	264,956	258,258	247,017	272,101	264,267	257,920	250,590
Trinidad	234,214	232,537	210,857	229,365	220,717	231,370	221,564	227,927	230,206[1]	222,780[1]	230,206[1]	222,780
Argentina[1]	288,930	218,000	202,000	221,000	220,000	221,000	217,500[1]	221,000	221,000	222,177	222,952	215,760
Peru[1]	175,667	166,281	146,286	159,774	151,973	142,367	138,782	146,000[1]	146,000[1]	147,810[1]	152,737[1]	147,810
Bahrein[6]	85,009	88,264	83,180	89,811	85,920	85,353	85,665	91,551	95,348	87,030	89,931	87,030
Burma[7]	89,985	82,992	58,602	96,423	80,336	96,261	91,980	86,738[1]	86,738[1]	83,940[1]	86,738	83,940
Canada[8]	61,812	68,244	45,581	49,029	71,018	90,856	104,518	114,527	101,278	91,736	103,875	82,950
Brunei[9]	66,939	66,410	59,474	65,749	62,271	65,007	61,996	65,474	65,500	63,180[1]	65,286	63,180
Great Germany: Old Reich[14]	45,111	47,562	47,614	56,654	53,357	58,205	53,412	55,927	58,300[1]	53,190[1]	54,963[1]	53,190
Ostmark[15]	5,111	5,014	6,962	6,454	8,106	9,666	11,289	12,691	13,000[1]	9,030[1]	9,331[1]	9,030
Slovakia and Moravia	1,443	1,545	1,500[1]	1,500[1]	1,400[1]	1,500[1]	1,400[1]	1,600[1]	1,600[1]	1,550[1]	1,519	1,470
Poland	42,000	43,000	40,202	44,968	44,000[1]	45,000[1]	41,000[1]	45,000[1]	45,000[1]	42,960	44,392	42,960
Japan[10]	24,724	32,003	31,094	31,631	31,095	31,455	31,454	31,544	31,721	31,651	31,678[1]	34,062
British India[11]	30,045	35,045	29,445	32,602	14,568	17,638	18,932	25,389[1]	25,389[1]	24,570[1]	25,389[1]	24,570
Ecuador	27,336	27,781	22,628	23,986	23,190	25,491	25,539	27,272	26,910	25,540	25,495	25,050
Saudi Arabia	18,590	21,078	23,146	29,161	31,799	38,110	41,037	46,404	47,500	72,899	72,899	42,503
Sarawak[12]	15,540	15,199	13,848	14,823	14,183	14,386	13,329	13,797	14,539	14,070	14,539	14,070
Egypt[13]	31,617	44,008	43,002	47,193	46,897	52,568	60,730	62,342	62,936	51,810[1]	53,537	51,810
Italian Empire: Albania[16]	41,674	14,869	10,179	18,801	36,657	12,266	11,980	20,987	13,000[1]	16,678[1]	17,639	17,070
Italy	986	933	1,005	1,034	968	901	892	850	950[1]	961	961	930
France	6,000[1]	5,900[1]	5,500[1]	6,000[1]	5,700[1]	6,000[1]	5,700[1]	6,000[1]	6,000[1]	5,983	5,983	5,790
Hungary	6,167	6,619	6,670	9,049	9,000[1]	9,500[1]	9,000[1]	9,500[1]	9,500[1]	8,773	8,804	8,520
Bolivia[1]	1,130	1,100	900	1,000	1,000	1,000	1,000	1,000[1]	1,000[1]	1,023	1,023	990
Other Countries[17]	6,700	7,000	6,000	7,000	6,700	7,000	6,700	7,100	7,100	7,000	6,975	6,750
WORLD TOTAL	23,099,026	22,838,199	20,899,923	23,679,527	23,683,751	24,546,773	23,527,544	24,698,838	20,772,620	24,161,367	25,013,766	23,107,115

[3] Japanese Saghalin, Taiwan (Formosa) and Hokkaido included with Japan.
[11] Excluding Burma.
[12] Sarawak Oilfields, Ltd., figures.
[13] Anglo-Egyptian Oilfields, Ltd., figures.
[14] Prussia, Thuringia and Baden.
[15] Formerly known as Austria.
[16] Italian imports of Albanian crude oil.
[17] Estimate representing Morocco, Cuba, New Zealand, Barbados, Greece, Algeria, Yugoslavia, Australia, Great Britain, Kuwait and China.
[18] Official Figures—Petroleos Mexicanos.

Comparative Cumulative Daily Averages in Metric Tons

	Jan.-Nov. 1939	1938
United States	461,735	447,815
Soviet Union	80,994	79,332
Venezuela	83,428	74,687
Iran	28,403	27,780
Netherland India Sumatra	14,529	12,534
Borneo	4,604	4,663
Java	2,268	2,652
Ceram	297	228
Roumania	17,103	18,206
Mexico	14,930	13,170
Iraq	11,276	11,597
Colombia	8,353	8,126
Trinidad	7,426	6,688
Argentina	7,193	6,368
Peru	4,927	5,764
Bahrein	2,901	3,170
Burma	2,798	2,874
Canada	2,765	2,460
Brunei	2,106	1,883
Great Germany: Old Reich	1,773	1,514
Ostmark	301	155
Slovakia and Moravia	49	52
Poland	1,432	1,379
Japan	1,037	982
British India	818	863
Ecuador	834	875
Saudi Arabia	1,394	32
Sarawak	472	561
Egypt	1,727	481
Italian Empire: Albania	569	216
Italy	31	36
France	193	198
Hungary	284	91
Bolivia	33	36
Other Countries	225	50
WORLD TOTAL	769,249	737,152

Official Crude Oil Production Figures for 1932 to 1938 (Revised) in Metric Tons

	1938	1937	1936	1935	1934	1933	1932
United States	163,228,715	172,822,797	148,707,864	134,912,143	122,913,903	122,601,191	106,289,292
Soviet Union	28,859,000	27,867,025‡	27,384,900	25,241,100	24,092,700	21,330,100	21,389,380
Venezuela	27,845,286	27,733,926	22,945,299	21,990,373	20,112,115	17,293,193	17,085,334
Iran	10,358,495	10,330,480	8,329,289	7,607,500	7,657,970	7,200,093	6,548,941
Netherland India: Sumatra	4,662,836	4,490,137	4,114,710	3,759,006	3,535,035	2,999,352	2,492,742
Borneo	1,719,783	1,739,607	1,773,545	1,815,998	1,924,234	2,013,849	2,043,707
Java	933,595	960,125	499,097	464,757	510,320	483,331	515,187
Ceram	81,560	72,139	50,446	41,862	36,738	38,300	41,605
Roumania	6,603,000	7,153,000	8,704,000	8,394,000	8,473,355	7,387,000	7,350,321
Mexico	5,716,423	6,896,657	6,090,842	5,973,955	5,666,857	5,049,109	4,870,175
Iraq	4,345,000	4,126,185	4,079,066	3,724,231	1,048,108	147,943	118,887
Colombia	3,007,935	2,844,251	2,614,092	2,452,635	2,416,432	1,833,606	2,287,835
Trinidad	2,472,943	2,181,676	1,862,796	1,642,446	1,533,122	1,345,532	1,425,009
Argentina	2,432,857	2,330,063	2,202,304	2,036,903	1,997,706	1,950,499	1,871,882
Peru	9,099,885	2,313,691	2,331,454	2,260,903	2,161,990	1,756,867	1,311,856
Bahrein	1,130,734	1,058,557	635,555	173,072	39,008	4,293	123
Burma	1,039,960	1,083,391	1,047,593	991,456	1,004,951	982,233	976,589
Canada	876,016	378,430	190,495	182,820	178,233	144,686	131,937
Brunei	707,123	576,545	470,991	471,842	386,478	290,808	171,432
Great Germany: Old Reich	552,074	453,451	444,600	427,400	317,500	238,600	229,700
Ostmark	63,468	33,010	7,473	6,616	4,172	860	120
Slovakia and Moravia	19,282	18,036	18,665	19,946	25,971	17,776	18,493
Poland	504,678	501,301	510,630	614,760	529,200	550,670	556,680
Japan	356,328	341,040	341,976	326,580	266,520	212,667	239,567
British India	322,125	298,450	273,137	281,072	265,341	224,879	240,767
Ecuador	319,877	306,326	275,293	245,434	231,947	229,578	226,423
Saudi Arabia	66,683	8,070	2,447	Nil	Nil	Nil	Nil
Sarawak	200,126	217,085	221,126	253,799	277,513	315,259	332,819
Egypt	223,058	166,298	177,491	176,436	214,671	232,437	265,055
Italian Empire: Albania	65,313	56,760	32,760	6,152	2,500	1,707	1,375
Italy	13,178	14,000	16,106	15,977	20,180	26,526	27,046
France	72,106	71,008	74,788	74,172	98,025	110,120	105,758
Hungary	42,798	13,910	13	Nil	Nil	Nil	Nil
Bolivia	13,262	15,487	13,197	20,540	19,858	14,085	5,284
Other Countries	34,080	10,000	5,300	4,600	9,100	7,700	10,500
WORLD TOTAL	277,989,582	279,482,914	246,449,340	226,610,486	207,971,753	197,034,849	179,181,741

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox

GEOPHYSICS

Geochemical Prospecting—Leo Horvitz, in GEOPHYSICS, Vol. 4 (1939), No. 3, pp. 210-228.

The results described in this paper indicate that soil analysis, in its present stage of development, is a valuable aid in prospecting for petroleum deposits. At present research is being directed towards improving the methods for the extraction and determination of the various constituents of the soil, and the development of more rapid methods of analysis. Studies concerning the specific adsorptive properties of various types of soils are being initiated with the hope that such information will increase the accuracy of the methods.

Experiments also are being carried on to determine the rate of formation, the origin, and the method of formation of the various constituents of soil-wax—a most interesting and empirically significant material.

Note.—As is the case with all new propositions, the idea of finding oil by analyzing the soil lying above the hidden oil deposits has aroused some skepticism. There undoubtedly are some points remaining to be cleared up, but the proponents of the method base themselves on the results of many thousands of analyses, and are able to point to some interesting circumstances which may or may not be susceptible of generalization.—Ed.

Relation of Geophysics to Geology—F. M. Kannenstine, in GEOPHYSICS, Vol. 4 (1939), No. 3, pp. 149-154.

The author takes the view that, even in the case of the relatively rare stratigraphic accumulations of oil and gas such as in the East Texas field, present geophysical methods are of definite value, and are invaluable for the discovery of definite structures. All geophysical methods, however, are not equally efficient. The different systems are appraised as follows:

The refraction seismograph has given an excellent account of itself in the Gulf Coast region, and probably can still be used successfully in some cases, depending on the size and amount of uplift over the structures. Anomalies cannot be localized closely when long refraction shots are used. This necessitates a follow-up by other methods.

The torsion balance also found an ideal situation in the Gulf Coast. In this region, it has many oil-bearing structures to its credit. It often shows an anomaly, however, where none exists in the sedimentary beds. In most areas, very detailed and extensive work must be done to extract regional variations from the results in order to be sure that any anomaly found is not entirely associated with the basement complex.

The chief weakness of the magnetometer is that it does not show a non-structural area as negative. Its chief value would seem to be in general problems such as the tracing of granite ridges. Even here it is necessary to check by another method before much reliance can be placed in the results.

The electrical methods, although they have been in limited use for several years, apparently are still in the experimental stage. Some interesting results have been obtained on carefully selected problems; but, in general, their usefulness is quite limited. The depth to which these methods work dependably is too small to allow general application of electrical methods. Simple geologic sections seem to be necessary for satisfactory interpretation.

Radio-activity measurements, thermal measurements, and chemical analysis of soil and soil gas are of undemonstrated value.

The gravimeter has much the same limitations as the torsion balance, but, because of faster operation, lower cost, and greater freedom from nearby surface effects, it appears much more attractive as a reconnaissance instrument than the torsion balance.

The reflection seismograph has a brilliant record of performance and is free from many of the faults of other methods. No other method compares with it in ability to find structure and to detail it. It is the only method which will give accurate depths to definite beds. It has no serious depth limitations. It comes closer than any other geophysical method to showing regularity where there is very little likelihood of structure existing. While there are limited areas where results are poor, there are no vast areas where satisfactory results cannot be obtained.

GEOLOGY

Operation of a Gulf Coast Field on Soil Survey Information—D. H. Stormont, in OIL & GAS JOURNAL, Vol. 38 (1939), No. 10, pp. 28-29.

The discovery of an oil field in San Patricio county, southwest Texas, is cited as an example of the legitimate use of chemical prospecting (soil survey) in exploring for oil. Drilling of the discovery well was begun on the basis of other information and belief before the soil survey was undertaken, but the results of the survey were known long before the drill reached the oil sand, and were very favorable. Thus the value of soil surveys in oil prospecting is again indicated even if the method cannot take full credit for this discovery. Beyond that, the survey has had a positive value in this case, in that it has indicated the extent of the field, and the operator is thus relieved of some of the risk of drilling dry holes to outline the field.

In this case the close association of hydrocarbon concentration with mineralization of the soil (soluble mineral content) is pointed out. The fact is that high oil content and high mineralization of the soil seem to go together, thus affording two entirely independent methods of chemical testing, one of which is based on the organic and the other on the inorganic contents. The association of the two is explained as follows:

The migration of gases from oil and gas accumulations is essentially vertical; in moving toward the surface the gases will carry some of the subsurface waters with them. In so doing they also will transport some of the minerals dissolved in these waters. The relative quantities of different minerals so transported will depend, of course, on their concentrations in the subsurface waters, also their relative densities and perhaps their molecular size, and finally on the proximity of the particular waters to the surface. The concentration of these minerals naturally will be greatest where the leakage of gas is greatest and as a result should be of service in exploring for buried oil and gas deposits. Concentrations of these minerals near the surface of the earth are very appreciable and are related significantly to buried oil and gas fields.

DRILLING

A Resumé of the Application of Gravel Packing to Oil Wells in California—W. A. Clark, in PETROLEUM TECHNOLOGY; Technical Publication, No. 1079 (1939), 8 pages.

The production of sand in an oil well increases operating costs because of abnormal wear in subsurface equipment, the necessity for frequent cleanouts, and the need for a means of sand disposal. Moreover, removal of sand from the zone can bring about the creation of cavities from which bodies of formation, sand or shale, may slough into the hole, endangering the shutoff, impeding production or collapsing the liner. The procedure known as gravel packing is attracting attention as a means of controlling these factors and contributing to the productive life of a well. That gravel packing is now substantially beyond the preliminary stage on the Pacific coast is reflected in the 191,000 bbl. of oil produced monthly by the 66 gravel-packed wells in 11 different producing sectors.

Several methods of installing the liner and gravel have been applied:

A liner containing a suitable conduit formed by blanking the perforations with cement, or by means of a wash pipe, is hung at the bottom of the hole. The suspending string is packed off at the surface. Gravel is then alternately dribbled or pumped into the annular space between the casing and the suspending string and washed down the hole by reversed circulation.

The gravel is placed, or dumped, into the open hole, filling it to the shoe of the primary casing. The perforated casing is washed, jetted or otherwise forced through the gravel to the bottom of the hole.

The gravel is placed in the open hole and the well is produced through the gravel alone without the use of a perforated string.

The liner with a basket at its bottom end is hung above the shoe of the primary casing. The annular space between the casing and the liner is filled with an amount of gravel calculated to fill the zone, and the liner and gravel are lowered to bottom.

The method first mentioned is used most frequently.

The mechanics of installing a gravel sheath around a liner in the bottom of a well are feasible and practical. It is relatively inexpensive, the extra cost being as a rule not more than 10 percent of the total cost of drilling the well.

Field results have proved that current production rates of gravel-packed wells are more sustained than those of wells conventionally completed, except in a few instances as noted. Reduction of downtime caused by sanding conditions results in a cumulative production that favors the former type.

Indicated reduction in sand production will result in lessened maintenance and equipment replacement costs. Savings thus effected will pay for the extra cost of the gravel pack within a period of one to three years, and yield a considerable profit thereafter. This does not take into account possible intangible savings that may result from the prevention of collapsed oil strings.

OPERATING

Multistage Separation of Crude—H. S. Gilson, in PETROLEUM TECHNOLOGY, Vol. 2 (1939), No. 3, Technical Publication No. 1085; 12 pages.

A process known locally as multistage stabilization has been developed in the Haft Kel field of the Anglo-Iranian Oil Co. in southwest Iran, for the recovery of casinghead gasoline. It consists in releasing the dissolved gases from the crude by stages, a practice common in many fields, but which, so far as is known, has nowhere been carried to the extent to which it is employed in Iran. It has been in use there for nearly nine years, during which time some 200,000,000 bbl. of crude have been handled by the process. This process of gasoline retention consists in preventing the greater part of the casinghead gasoline hydrocarbons (the butanes and pentanes) from ever leaving the crude, instead of allowing them to be vaporized and then recovered from the lighter gases by the usual compression or absorption processes. Its efficiency is fully equal to that obtained by the absorption process; its disadvantage is that it increases the quantities of ethane and propane in the crude sent to the refinery, but with the growing demand for propane this drawback is vanishing.

When casinghead gasoline is recovered as a separate liquid in the Iranian fields, it is blended with the crude, as the only outlet is through the refinery, and the crude-oil pipe line offers the cheapest means of transportation. It is under these conditions that the retention of the butanes and pentanes in the crude by multistage stabilization is a most attractive process, possessing as it does the following advantages: (1) extreme simplicity; (2) low first cost; (3) easy installation; (4) practically 100 percent operating-time efficiency; (5) no operators required; (6) no water or other services required; (7) negligible maintenance; (8) once established, very little routine testing is necessary.

The one essential for reasonably efficient multistage stabilization is that the flowing pressures of the wells should be relatively high; i.e., they should not be less than about one-third the saturation pressure of the crude in the reservoir. This is a very general statement, and much depends on the type of crude and its temperature.

At Haft Kel the well pressures are between 500 and 750 lb. per square inch. The first reduction is to 218 lb., decreasing to 102, 55, 34 and 25 lb. absolute. The average temperature is 80 deg. F. with a winter-summer range of 40 deg.–140 deg.F. The pressure on entering the pipe line is 10 lb. gage which at the refinery end, 125 mi. away, may rise to 30 lb. gage.

Specific Problems in the Chemistry of Acidizing Wells—C. E. Clason, in PETROLEUM ENGINEER, Vol. 10 (1939), No. 12, pp. 72, 74, 75.

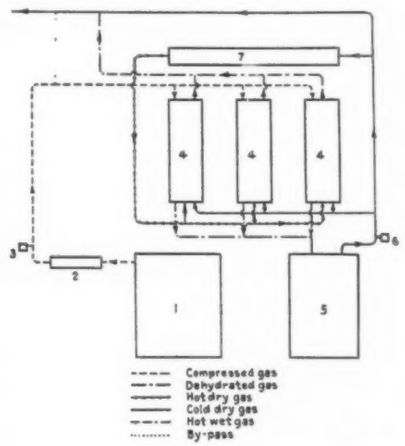
The general thesis of this paper is that any one who thinks that treating a well with acid to dissolve out soluble material is a matter of elementary chemistry is much mistaken. To be sure, the reactions themselves are simple and are within the comprehension of any high school student of chemistry, but the consequences may be exceedingly complex.

Associated with the limestones of oil formations is gypsum which may remain to plug the passages opened by the acid, or it may be kept in suspension and removed from the well according to how the acid is made up and handled. This is a complicated situation that has to be studied out in each individual case. It is the same with acid-soluble silicates and with magnesium carbonate; these substances may remain in the well and defeat the operation, or they may be put into a condition such that they will come out with the spent acid, all depending on the composition of the acid and its content of inhibitors, wetting agents and anti-emulsifiers. This field is one for the expert who has a large background of experience, and who can sense the peculiarities of each individual well and formation.

NATURAL GAS

Dehydrating Natural Gas by Silica Gel.—H. de Raay, in PETROLEUM ENGINEER, Vol. 10 (1939), No. 12, pp. 45, 48.

This article describes a silica gel plant for dehydrating natural gas that has been in successful operation for many years in the Mene Grande field of Venezuela.



The gas from the field is compressed with the double object of facilitating the recovery of gasoline and for obtaining gas under sufficient pressure for gas lifting operations at the wells. The object of drying is to prevent freezing in the subsequent operation of refrigeration.

The operations follow the scheme indicated in the accompanying diagram.

The gas is compressed at 1, cooled at 2, the condensed gasoline is extracted at 3, the moisture in the gas is absorbed in the three silica gel absorbers 4, the moisture-free wet gas is refrigerated at 5 and the liquid gasoline thus obtained is collected at 6. A part of the cooled, dry, lean gas is heated in 7 for expelling absorbed moisture from the silica gel: another part of the cold gas is used for rapid cooling of the absorbers after they are dried. A certain amount of gasoline is retained by the silica gel and is expelled during the heating period, but if the heating gas is returned to the wells for gas-lift will return to the compression plant.

Gasoline lost in the operation amounts to about 0.06 gallon per 1,000 cu. ft.

REFINING

Desulphuring Gasolines with Aluminum Chloride—A. Y. Semyonova and D. L. Goldstein, in OIL INDUSTRY (Neft. Khoz., Russian) Vol. 20 (1939), No. 2, pp. 31-35.

Aluminum chloride was found to be highly effective in desulphuring gasolines obtained from certain Russian crudes high in sulphur content. The operations were conducted at or near the ordinary temperature (20 to 40 deg. C.). The reaction products are complex compounds that are liquid and hence do not tend to obstruct pumping operations, so that the process may be semi-continuous. The treatment is most successful if the gasoline is first given an alkali wash. On the other hand, less than optimum results are obtained if the gasoline has been stored for some time before treatment; evidently, the sulphur compounds become less tractable with age.

Under laboratory conditions the sulphur content may be reduced from 0.48 (original content) down to 0.039 percent and even lower, depending on the efficiency with which the mixture is agitated. About an hour is required to complete the reaction within the desired limits. The work may be carried on under ordinary atmospheric pressure. Tests in a pilot plant confirmed the laboratory findings. The consumption of aluminum chloride can be limited to 0.35 to 0.4 percent if the used liquid is recovered and returned to the system after fortification with the required amount of fresh aluminum chloride.

The lead susceptibility of gasolines treated by this method is much improved; three cubic centimeters of tetraethyl lead has been sufficient to raise octane numbers by 21 to 28 points.

Propane Precipitation of Petroleum Resins—P. T. Graff and H. O. Forrest, before AMERICAN CHEMICAL SOCIETY, Boston, 1939.

Petroleum resins may be precipitated out of solutions of liquid propane and viscous fractions of crude petroleum at temperatures of 125 deg. to 180 deg. F. The resins so produced may be narrow fractions containing color and carbon-forming material or wider fractions containing also very high viscosity oil of a naphthenic or paraffinic type. Operations are shown of propane precipitation of resins from several crude petroleum residua; some physical characteristics of these resins are given. The resins may be treated with selective solvents or further settled in propane solutions to obtain products not usually realized from petroleum.

PHYSICS

Evaluation of Light Motor Fuels as Regards Vapor Formation (Vapor Lock)—Th. Hammerich, in OEL UND KOHLE, Vol. 15 (1939), No. 29, pp. 569-572.

The known physico-chemical testing methods, in conjunction with the octane number as determined by the motor method, are sufficient to disclose the practical value of a motor fuel in all particulars—except the tendency to produce the disagreeable phenomenon known as vapor lock. Vapor lock, or the tendency to form bubbles of vapor that obstruct the flow of liquid fuel from the gasoline tank to the engine heretofore has not been evaluated satisfactorily by any current method. The A. S. T. M. 10 percent point does not characterize satisfactorily the volatility of the fuel, and it fails entirely with mixed fuels containing alcohol or benzol. The Reid vapor pressure test is merely a qualitative test which, by itself, is insufficient to characterize the vapor-lock tendency of a fuel.

On the other hand, the author has tested a great variety of fuel mixtures, including ordinary gasolines of all grades made from natural and synthetic hydrocarbons with and without mixture with alcohol and/or benzol, and finds that the average of the portions which pass over between 50 deg. and 70 deg. in the A. S. T. M. distillation, taken in conjunction with the Reid vapor pressure, can be used as an indication of the tendency to form vapor bubbles.

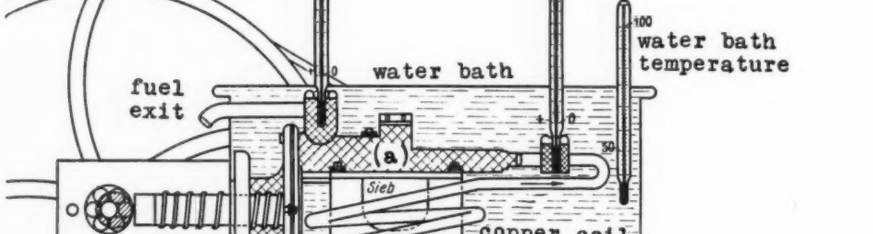
Aside from that, the author has worked out a method for a direct measurement of the temperature at which vapor-bubble formation will occur. The essentials of the apparatus are seen in the accompanying drawing. It consists of a water bath surrounding a coil of long narrow copper tubing through which the fuel is aspirated by a membrane pump actuated by a motor. The temperature of the bath is raised to a point where, after passing a No. 60 spray at the base of the thermometer indicating breaking temperature, bubbles will form in an enlargement of the fuel passage, (a) (filled with small copper rings) sufficiently to prevent passage of liquid through the fuel exit. This vapor lock temperature is measurable with an accuracy of plus or minus 1 deg. C.

For orientation purposes, the relative breaking temperature (BT) can be calculated from the volatility (Fluchtigkeit: Fl.) and the Reid vapor pressure by the formula:

$$\text{Rel. BT} = \frac{30 - \text{Fl.}}{\tan a} + 48$$

the volatility here referring to the average of the 50–70 deg. points of the A. S. T. M. distillation test.

The author also describes an apparatus for accurate fractionation and weighing of the C_3 and C_4 constituents of a gasoline.



Film-Forming Action of Lead Naphthenate and Free Sulfur in Extreme Pressure Lubricants—G. L. Simard, H. W. Russell, and H. R. Nelson, before AMERICAN CHEMICAL SOCIETY, Boston, 1939.

Electron diffraction methods have been applied to the study of chemically formed films produced on iron, copper, bronze, tin and babbitt when heated or subjected to friction in lead naphthenate and free sulfur lubricants. Free sulfur in oils promotes the formation of oxides on iron and sulfides on copper and bronze. Oils containing lead naphthenate alone form adherent lead-containing films which are characterized by amorphous type diffraction patterns. When both additions are present, the metal is covered by a layer of lead sulfate over which lead sulfide forms. This action is more rapid in commercial base oils than in highly refined oils.

CHEMISTRY

The Behavior of Naphtha Solutions of Free Sulphur and Sulphur Compounds Upon the Distillation-Corrosion and Copper Strip Corrosion Tests, and the Sensitivity of the Doctor Test—L. M. Henderson, M. S. Agruss, and George W. Ayers, Jr., before AMERICAN CHEMICAL SOCIETY, Boston, 1939.

Solutions of free sulphur and organic sulphur compounds in naphthas were examined for corrosiveness to copper (1) during an A. S. T. M. distillation with a copper strip placed vertically in the distillation flask (distillation-corrosion test), and (2) in the ordinary copper strip corrosion test for three hours at 122 deg. F. The results from (1) show that there are two determining factors: (a) the b.p. of the sulphur compound with reference to the boiling range and end point of the naphtha, and (b) the stability of the sulphur compound at moderately high temperatures. Of the mercaptans, sulfides, and disulfides investigated, none affected the copper strip corrosion test at 122 deg. F. The sensitivities of seven mercaptans in napthas to the doctor test are listed. The type of container used for the test affects the sensitivity of the doctor test.

ASPHALT

Methods for Characterizing and Analyzing Asphalts—H. Suida and F. Motz, in PETROLEUM Vol. 35 (1939), No. 30, pp. 527-533.

In the absence of exact knowledge of the nature and chemical composition of asphalt, it is the practice to evaluate asphalts mainly by physical characters (viscosities, specific gravity, etc.) and by the solubility and the amount of the various constituent fractions. Many methods for such fractionations by the use of solvents have been proposed and used.

As the outcome of an extensive investigation at the Vienna Institute for Chemical Technology, the authors have concluded that the basic fault of all analytical methods for separating asphalt into its main constituents has been failure to recognize the importance of temperature in the extraction process. What previous investigators have omitted to do is to select a standard temperature and stick rigorously to it. Here they present such a method, which they consider is of a character that will render further search for a suitable method unnecessary, at least for the time being.

The method makes use of a Soxhlet extraction apparatus, wherein a weighed amount of dry absorbent earth is placed in extraction thimble, which is fixed so that a stirrer can be operated inside of it. A weighed amount of the asphalt (one gram) is dissolved in 30 cc. of chloroform, poured into the extractor and continuously extracted by a stream of chloroform delivered from a boiling flask and condenser the temperature of the condensate being fixedly maintained at 20 deg. C. Air is kept out of the apparatus by a current of nitrogen gas to prevent oxidation. The chloroform extract contains the petroleum hydrocarbons and petroleum resins. Next the asphalt in the extractor is extracted with pyridin, also at 20 deg. C. This gives the asphalt resins. Finally, an extraction with pyridine at 50 deg. C. gives the hard asphalt. The operation requires 10 hours, as compared with 18 to 56 hours required by other methods.

USES

Oils and the Lubrication Problem—Michel Roegiers, in JOURNAL DES PETROLES, Vol. 6 (1939), No. 125, pp. 1-5.

After presenting a review of the theories of viscosity and lubrication the author lists the advantages of electrionized oils. These are oils which have been subjected to the action of a silent electric discharge according to a patented process. The result of this procedure appears to be an

alteration in the natures of substances contained in the oil that, under operating conditions, would tend to become oxidized; it is these oxidation products that become insoluble in the form of gum or sludge that disturb the normal functions of the engine and the oil. Electrionization of the oil, while perhaps not preventing the formation of oxidation products, keeps them in a state of finely dispersed colloidal suspension, so they cannot settle out as gum or sludge; this applies also to carbon formed in the process of combustion, and to water which may be accidentally introduced. The treated oils are said to be especially suitable for Diesel engines, in which combustion is less complete than in gasoline engines, and consequently Diesel engines are fouled to a greater extent.

It is further stated that there may be extracted from electrionized oils an electrion concentrate which imparts desirable properties to common lubricating oils.

Data are presented to show that electrionized oils have a flatter viscosity index curve than any other motor oil on the Belgian market.

SUBSTITUTES

Hydrogenation Tests on Canadian Coal—T. E. Warren, K. W. Bowles and R. E. Gilmore, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 31 (1939), No. 8, pp. 1021-1025.

Hydrogenation tests on nine coals representative of various groups in the A. S. T. M. classification beginning medium-volatile bituminous coal and lignite are described. The method of testing was based on continuous operation in a liquid-phase plant having a capacity of about nine pounds of coal paste per hour. The vehicle in each case was oil produced previously by the hydrogenation of the coal being tested.

The rank of the coal had a fairly consistent influence on the yields although one of the coals was exceptional. The bituminous high-volatile A and B groups gave the highest yields of oil. The effects of composition of ash, geological age, and proportions of nitrogen and sulphur, although largely obscured by the effect of rank, were also studied. The composition of the ash did not appear to have an appreciable influence, and geological age also had only a minor effect, if any, on the yields. There is an apparent relation, fairly consistent throughout the present series, between the nitrogen content of the coal and the degree of liquefaction.

A sample of coal used for commercial hydrogenation in England was included in the series as a standard of comparison. It yielded 71.5 percent of primary oil on the ash- and mositure-free basis. Two of the Canadian coals gave yields of 77.2 and 73.8 percent, and the lowest yield of all the coals tested was 53.3 percent. On the basis of ash as charged and moisture as mined, only one Canadian coal gave a higher yield of primary oil than the standard, and the yields diminished progressively with descending rank to about one half that of the standard.

ECONOMICS

Growth of the World's Tanker Fleet—Oskar Tokayer, in PETROLEUM PRESS SERVICE, Vol. 6 (1939), No. 29, pp. 352-353.

In any consideration of war-time oil supply the matter of available tankage tonnage and its ownership is of great importance. According to the most recent summary of Lloyds Register of Shipping the present situation is represented by the table below.

World's Tanker Fleet*

	1939	1938	1937
Great Britain and Dominions	3,264,241	3,013,687	2,886,864
U. S. A.	2,800,780	2,758,642	2,575,199
Norway	2,117,381	1,972,469	1,856,250
Netherlands	537,564	561,946	447,308
Panama	469,664	450,261	397,159
Japan	429,790	345,849	222,792
Italy	426,002	380,488	356,343
France	317,913	241,896	241,880
Germany	256,093	202,221	159,995
Sweden	158,815	144,899	128,507
Other countries	658,637	643,322	684,843
Total	11,436,880	10,715,680	9,957,140

*Including vessels of 1,000 gross tons and upwards.

The average annual increase during the past three years has been equivalent to about 750,000 tons. This rate of growth has been relatively more rapid than that for all steam and motor ships taken together; out of a total tonnage of all vessels on the register amounting to 69,439,569 gross tons this year, tankers represented 16.7 per cent, against no more than 14.5 percent of the total world tonnage three years ago.

Three countries, Great Britain, the United States and Norway, own more than 71 percent of the world's tank fleet.

GENERAL

Helium: Sources, Production and Use—A. W. Trusty, in REFINER, Vol. 18 (1939), No. 8, pp. 325-326.

High concentrations of helium have been found in three groups of natural gases: gases from mineral wells, volcanic gases and petroleum gases. Each of these gases, however, may occur practically free from helium. Gases containing more than one percent of helium (which is generally considered as the lower limit for economical extraction) are uncommon even in the United States. The most important of the United States fields are the property of the government. While the Cliffside Field (Potter County, Texas), is exclusively used at present for drawing all helium necessary for the government, others are retained where the helium is stored in its natural reservoir underground. An estimate of the known helium reserves is shown:

	Cubic Ft.
Eastern Rocky Mountain District:	
Southeastern Colorado	88,000,000
Northeastern New Mexico	8,000,000
Northwestern Texas	1,180,000,000
Western Rocky Mountain District:	
Southwestern Wyoming	2,399,000,000
Utah	216,000,000
Central District:	
Kansas	2,037,000,000
Grand Total	5,928,000,000

At present the only government plant is located near Amarillo. It is estimated that the reserve supply of gas for the Amarillo plant is 100,000,000,000 cu. ft. with a recoverable helium content of about 1.8 percent.

The Amarillo plant produced in the six years prior to 1935 more than 60,000,000 cu. ft. of helium of 98 percent purity. The cost of the helium has been reduced from $34 per 1000 cu. ft. to a gross cost of $8.20. Allowing for returns from the sale of the residue gas, the net cost of production is about $6.00 per 1000 cu. ft.

Natural gas with much larger helium content is found in various parts of the United States: Musselshell county, Montana, 16 percent; Los Animas county, Colorado, 8.64 percent; Grande County, Utah, 7.07 percent.

BOOKS

Petroleum Development and Technology, 1939. Published 1939 by American Institute of Mining and Metallurgical Engineers, New York; 625 pages, $5.00.

This annual volume compiled by the Petroleum Division of the Institute is composed of two parts.

The first part comprises articles on various phases of petroleum technology contributed by members of the Institute: It occupies the first third of the volume and is divided into three chapters: Production engineering, engineering research and petroleum economics. A number of these papers have already been published in Petroleum Technology, the Institute's quarterly journal in the petroleum field. The other two-thirds of the volume presents a comprehensive annual survey of oil production in the United States and in foreign countries. The text is concluded by an estimate of world oil reserves by V. R. Garfias and R. V. Whetsel, and a review of Refinery Engineering for 1938.

Handbook of Chemistry—Norbert Adolph Lange, and Others. Published 1939 by Handbook Publishers, Inc., Sandusky, Ohio, 3rd revised one enlarged edition; 1386+249+34 pages, 5½ x 8 in.

This book perhaps comes the nearest to being a reference volume for all persons requiring ready access to chemical and physical data used in laboratory work and manufacturing; at least it is the most complete which has lately come to the notice of this reviewer. The body of the book, 1543 pages contains about everything 99 percent of research and working chemists usually look for, and in many cases do not find—physical constants of every important mineral product as well as of organic and inorganic chemicals; the list of organic chemicals that are described contains more than 4,000 entries. Other divisions, too numerous even to mention, are covered with comparable completeness. The table of contents has 1542 headings. There is a 249 page section devoted to mathematical tables and formulas, and the double columned index covers 34 pages. All that remains to say is that possession of this book will be a big help to chemists in every line including those interested in the data of physical chemistry and thermodynamics.

Famous Cities of Iran—By Laurence Lockhart, published 1939 by Walter Pearce and Co., Brentford, Middlesex, England; 115 pages.

Now that the ancient land of the Persians has been made accessible to travelers over the railways and motor roads built under the stimulus of the country's present vigorous and progressive ruler, it is more than likely to attract tourists eager to see new lands. However, even stay-at-homes may find much interest and pleasure in looking at the many excellent photographs of scenes and notable buildings in these 16 Iranian cities, and in reading the mixture of striking fact and glamorous legend which the author has put into his text. Although the book contains nothing about petroleum, it may be added to the list of works to be read by those interested in this up and coming oil country.

German Process for Preparing Fatty Acids from Synthetic Paraffin—W. Schrauth, in CHEMIKER ZEITUNG, April 19, 1939.

In the Fischer-Tropsch process for synthesizing petroleum from carbon monoxide and hydrogen, a large yield of paraffins is obtained under certain operating conditions. These paraffins are cheap enough to be considered as a source of fatty acids. The process under consideration consists in heating the paraffin to about 100 deg. C., mixing it with a catalyst and passing air through the mixture at the rate of 72 cu. met. per 100 kg. of paraffin during a period of 24 hours. The reaction product contains 30 to 40 percent of crude fatty acid and has a saponification number of 130 to 150. These acids are formed from straight or nearly straight chained hydrocarbons, and the point of oxidative attack seems to be about the middle of the chain. The fatty acids thus produced have odd as well as even numbers of carbon atoms in the molecule; this contrasts with natural fatty acids, which are even numbered. Some acids of low molecular weight are formed; these are unsuitable for soap production.

The process depends on good control of the temperature; a few degrees above 100 deg. C. is sufficent to cause a considerable increase in the formation of peroxides. The choice of the grade of paraffin is also important; a wax with an initial boiling point of around 350 deg. C. gives a considerably smaller yield of low-boiling fatty acids than a paraffin with initial boiling point of 320 deg. to 330 deg. C.

The crude product is washed with alkali, and the soaps thus formed are decomposed with mineral acid. After thorough washing, the liberated acids are distilled under a high vacuum; the yield of fatty acids suitable for soap production is from 50 to 80 percent of the material charged into the vacuum still.

The percentage composition of a representative distillate is: Caprylic, 0.2 percent; pelargonic, 1.6 percent; capric, 4.1 percent; undecanic, 8.0 percent; lauric, 11.2 percent; tridecanic, 13.5 percent; myristic, 14.3 percent; pentadecanic, 14.8 percent; palmitic, 10.9 percent; heptadecanic, 7.8 percent; octadecanic, 6.8 percent; and higher acids, 6.8 percent.

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Gas Evolution in Petrol Storage Tanks Caused by Micro-organisms—A. C. Thaysen, in JOURNAL INSTITUTE PETROLEUM, Vol. 25 (1939), No. 189, pp. 411-415.

Experiments and observations are reported to show that microbiological activity can go on in water contained in the bottoms of tanks in which refined petroleum products, such as kerosene, are stored. Such water is usually taken from rivers or tidal inlets that contain organic and mineral matters, including sulphates. The latter salts are reduced by sulphate-reducing organisms, with liberation of hydrogen sulphide which not only corrodes the steel wall of the tank, but contaminates the previously sulphur-free petroleum product.

Dangerous Gases in the Petroleum and Allied Industries—A symposium, Part II, JOURNAL INSTITUTE PETROLEUM, Vol. 25 (1939), No. 189.

This number of the above named periodical continues the discussion of safety measures for prevention of explosions and fires. The papers in this concluding series include the following: Gas evolution in petrol storage tanks; protection from dangerous gases in oil tanks; flue-gas protection for ships' tanks; automatic recorder for inflammable gases; vapor detectors in the petroleum industry; "Riken" explosive gas indicator; inflammability of hydro-carbon-air mixtures. All these papers are extensively discussed by various speakers.

Note.—As was previously mentioned, this collection of studies is well worth serious study by members of the oil industry interested in safety programs.—Ed.

CORRECTION

DUE to an oversight which is a matter of regret to the editors, the advertisement of the United States Steel Export Company, appearing on page 127 of the December (Venezuelan) issue of WORLD PETROLEUM, was incorrectly listed in the advertising index which accompanied that edition.

FOREIGN OIL LEGION

(Continued from page 41)

T. M. SMITH has recently returned to Houston from a flying trip through Trinidad, Colombia and Venezuela. He has been a member of the W-K-M Company of Houston, Texas, for several years, and has spent over twenty years in the oil country, including a long period of service in Mexico.

PAUL MAY, full time W-K-M representative in Venezuela and Trinidad returned recently to his territory following a trip by air to Houston for a conference in connection with the company's expansion program. He went to South America more than a year ago for a study of drilling conditions and the equipment market after many years of experience in drilling and production work in the United States.

(Continued on page 50)

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T. M. Smith

Paul May

G. M. STEWART, export manager for W-K-M, left Houston the last week in 1939 for Miami, where he boarded a Pan-American Clipper to Buenos Aires for an extended tour of Argentine fields. He flew from his export headquarters in New York to Houston to attend the company's conference.

O. D. SMALL is scheduled to leave Houston in the near future for an extended trip to the Dutch East Indies, visiting the individual fields in Borneo, Sumatra, Java, and other active oil areas in that part of the world. Small is among the oil industry's most widely traveled sales representatives. He spent several years as an engineer for drilling and producing companies in Mexico and South America, and last year made an eleven months tour which took him into the most remote oil areas of every South American petroleum producing country.

This activity on the part of W-K-M's staff is part of a major expansion program for export distribution of the company's products and of those of other manufacturers which it handles for export distribution.

G. M. Stewart

O. D. Small

CHESTER CREBBS, president of the Mene Grande Oil Company C/A of Venezuela sailed from New York on Friday, January 12 aboard the Santa Paula on his way back to Venezuela where his company is engaged in the rapid expansion of the Oficina field in Eastern Venezuela. The pipeline from this field to Pto. La Cruz was opened this fall and regular shipments began in December, 1939. Mr. Crebbs had been in New York on business for several weeks and had spent Christmas in New Mexico. He was accompanied by Mr. DUENSING of the M. G. O. C. in Maracaibo. Sailing on the same ship were

WALDO SHELDON in charge of Socony-Vacuum's operations in Venezuela and HAROLD ATWOOD executive of the overseas personel department of Standard Oil Co. of Venezuela.

GASOLINE OF TOMORROW

(Continued from page 32)

like a monopoly of the field of high quality fuel. The handicap of a limited supply of iso-octane and other agents of high blending value is rapidly being removed by a series of brilliant new accomplishments of petroleum chemistry. Iso-octane, for example, has been scarce because it could be produced only by subjecting the butanes of natural gas and the olefins of cracked refinery gases to processes of polymerization, hydrogenation, isomerization and alkylation. Butanes and olefins themselves have been scarce, but their scarcity is now in a fair way to be largely relieved by new methods of converting pentanes, propane and even ethane into olefins that can be polymerized to produce large quantities of iso-octane and related substances of high blending value.

Further, catalytic processes are not now the only ones capable of producing the highest quality (and therefore the most highly efficient) automobile fuel direct from crude oil. Research reported to the A. P. I. by Oberfeld and Frey shows that cracked gas containing ethylene and iso-butane can be converted by thermal alkylation (with or without catalysis) into neohexane, which is the equivalent (or better) of iso-octane for blending up low grade gasolines from ordinary sources. This opens a wide additional field from which to obtain the fuel of the future in quantity. As cumulative evidence of an approaching abundance of high quality fuel may be mentioned a report by Schultze and Alden of the conversion of low grade sulfur-containing gasoline by first desulfurizing it, adding tetraethyl lead, and a greatly reduced minimum of iso-octane.

From the foregoing the reader may gather that the petroleum industry is on the threshold of a technological revolution of very considerable magnitude. Quality automotive fuel has definitely stepped beyond the limits of the aviation market, which in the United States consumes annually about 20,000,000 gal. One group of five companies that is exploiting the sulfuric acid catalytic process for producing blending stocks for 100 octane fuel has six plants in operation, with an annual capacity of around 37,000,000 gal. Eight additional plants, with a total annual capacity of around 125,000,000 gal., are being planned or considered. Who is going to use this greatly expanded supply of aviation gasoline? Commercial and military aviation will expand their consumption, and some will be exported; the rest evidently is destined for the higher compression automobile engines now built or soon to be produced.

It may be surmised that if the fuel of the

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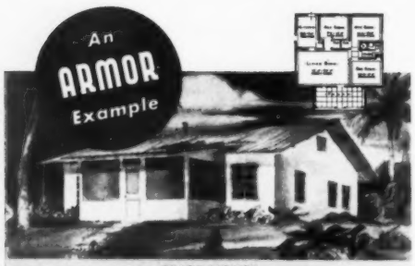

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future is to be fifty percent more efficient, and that if the refinery technologists bite still further into the margin afforded by the thermodynamic limit of 450 miles to the gallon, the demand for crude oil will be proportionally reduced, which may be reflected in smaller quotas for producing regions and wells. There may be compensation in higher prices which motorists may well pay on a cost per mile basis; or, if the price is not altered from present levels, the public may buy more cars and run them more miles for the same money. In either case the industry stands to lose nothing by its technological progress.

COLE BILL

(Continued from page 25)

In answer to close questioning by Representative Wolverton in regard to the shutdown led by Texas last August for a two-week period, he testified that the drastic price cut which preceded the shutdown was the result of heavy surplus stocks and was the final warning of oversupply. With this tremendous surplus and with the winter months coming on with a decreasing demand from consumers, the two-week shutdown was deemed advisable and necessary. "We simply sut the door before the horse was stolen."

"This bill would put the national administration in charge of the oil industry" said Col. Thompson, "and would take control from the states, where it belongs. It would mean unnecessary duplication from an administrative standpoint. If it passed, you might as well abolish the state agencies because the federal body would have the power to control waste and this power would affect everything the state might try to do. The will of the federal administrator would always prevail."

Representative Mapes agreed that the bill called for the federal body to have the final say in case of a dispute with any state regulatory group.

"Production in excess of estimated demand constitutes waste," defined Col. Thompson. "This means that you must have adequate transportation facilities, too. Crude oil evaporates in storage, sometimes to the extent of as much as five percent."

"Doesn't limitation of production increase price?" asked Representative Wolverton.

"Only theoretically. The price has continually dropped under Texas proration. But if prices are reduced to the point where the stripper wells cannot operate profitably, you do a great injustice."

"The Interstate act seems to want to stabilize the price for the industry even at the expense of the consumer, if necessary," remarked Representative Wolverton.

"The Compact," replied Col. Thompson, "took no action in the shutdown. Each state acted on its own initiative to protect the stripper wells and nothing else."

If the bill is passed, warned Col. Thompson, Texas will fight it through every court in the nation, if necessary.

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